NON-RESIDENTIAL
ALTERNATIVE WATER
RESOURCE GUIDE

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Smart Water Fund

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FORWARD

Water, its use, conservation and re-use are topical issues for Australians today. Climate change, combined with increased frequency and severity of droughts, as well as an increasing population means that Australia needs to make better use of its limited and unreliable water supplies.

This Non-Residential Alternative Water Resource Guide (The Guide) aims to provide decision makers with an outline of alternative water resource opportunities available for commercial, industrial and institutional applications. It also sets out a framework for prospective users to assess potential alternative water resource projects against environmental and financial criteria.

“All water resources are valuable

The water cycle is not limited to converting rainwater into drinking water. We can put water to better use by recycling and reusing it. We can also capture the potential of stormwater to ease the pressure on our rivers.” [1]

This Guide does not address residential water use and re-use; it focuses on providing clear guidelines and information for end users to access when thinking about non-residential water strategies. These strategies therefore focus less on water-saving techniques, though these are valuable tools in and of themselves. Instead, this Guide leads non-residential users through the possibilities currently available for alternative water supply creation, including the treatment and re-use of wastewater that they produce.

Achieving beneficial water use practices across a diverse range of applications requires education in broad principles as well as tools that accommodate the many highly specific ways water is used in a non-residential setting.

Effective non-residential alternative water use has the potential to result in an abundance of available water for the user concerned. Contrary to common conceptions of water efficiency and water restriction models, alternative water sourcing contributes to a sense of abundant available water, while at the same time reducing demands on surrounding ecosystems. For example Victoria used to be known as the ‘Garden State’, in an era of water restrictions, alternative water resources provide the potential to recapture this title.

A well-designed alternative water source reflects the natural organisms and ecosystems that inspire them, in that they continually store and purify water without significantly stressing fragile environments. Alternative water resources aid built environments in enhancing sustainability and removing themselves from competition with surrounding rivers and ecosystems.
<table>
<thead>
<tr>
<th>TERM</th>
<th>MEANING</th>
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</thead>
<tbody>
<tr>
<td>AWR</td>
<td>Alternative Water Resource</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand - a measure of the amount of oxygen used in the biochemical oxidation of organic matter. The BOD test is typically conducted over a period of five days under specified conditions and may then also be referenced as BOD5.</td>
</tr>
<tr>
<td>E.coli</td>
<td>Escherichia coli. A bacterium found in the gut of warm blooded animals that indicates faecal contamination.</td>
</tr>
<tr>
<td>EPA</td>
<td>The Victorian Environment Protection Authority</td>
</tr>
<tr>
<td>ESD</td>
<td>Ecologically Sustainable Development</td>
</tr>
<tr>
<td>IWM / IUWM</td>
<td>Integrated Water Management / Integrated Urban Water Management</td>
</tr>
<tr>
<td>MCA</td>
<td>Multi Criteria Analysis, also referred to in this guide as a TBL assessment.</td>
</tr>
<tr>
<td>NTU</td>
<td>Nephelometric Turbidity Unit — unit of measure of the turbidity of water due to suspended, colloidal and particulate matter.</td>
</tr>
<tr>
<td>Pathogens</td>
<td>Organisms capable of causing disease. In blackwater, the key potential pathogens are bacteria, viruses, protozoans and helminths.</td>
</tr>
<tr>
<td>pH</td>
<td>The measure of the acidity or alkalinity of water.</td>
</tr>
<tr>
<td>SS / TSS</td>
<td>Suspended Solids. / Total Suspended Solids</td>
</tr>
<tr>
<td>TBL</td>
<td>Triple Bottom Line, considering social, environmental and economic aspects of a business decision or project.</td>
</tr>
<tr>
<td>AWR PDA Tool</td>
<td>Alternative Water Resource Preliminary Design Assessment Tool presented in this guide.</td>
</tr>
<tr>
<td>WSUD</td>
<td>Water Sensitive Urban Design</td>
</tr>
</tbody>
</table>
1 INTRODUCTION

Drought and climate change have put unprecedented pressure on Australia’s water supplies. Many areas of Australia, particularly the southern states, have experienced increased variability in catchment inflows due to climate variability characterised by reduced winter rainfall and more intense summer storms and increased evaporation.

The southern and eastern coastal areas are experiencing more extreme weather events, with larger floods but also longer, more severe droughts. This change has put great pressure on water management authorities and the general public around Australia. An urgent response is required to climate uncertainty and the reduced reliability of our catchment dams.

Australians are being forced to face the limitations of this dry continent when it comes to fresh water supply. A new attitude to water has arisen, and water is becoming appreciated for what it is in Australia: an essential, often scarce and highly valuable resource. This new recognition of the true value of water has brought with it new thinking. New ways of collecting, saving, and reusing water are being implemented throughout our society, and range from individuals collecting excess water in the home to water the garden, through to treating wastewater and sea water on a mass scale to supplement our city water supplies, and everything in between.

For individuals in the residential environment there is an abundance of information and assistance available to help improve water use practices. This Guide instead addresses the non-residential setting, and aims to provide information and resources for commercial, industrial, and institutional water users.

The Guide outlines many of the options available to these users to decrease their reliance on fresh water supplies. It stays clear of describing strategies to save water, as these may be vastly for different for individual water user’s applications, and instead focuses on ways to access alternative water sources, in particular rainwater, stormwater, and reuse water (treated wastewater).

The Guide describes alternative water sources in some detail, and used in conjunction with the Alternative Water Resource Preliminary Design Assessment to provide practical guidance to those wishing to assess the suitability of alternative water sources for their non-residential activities.

Refer to the Melbourne Water website or contact your local water authority or council for more information about residential water use programs.
1.1 Who should use this guide?

The guide, along with the AWR PDA Tool aims to assist water users within non-residential buildings. It is suggested that the guide and the AWR PDA Tool would be applicable to a variety of users, including owners, operators, facility managers, and capital works coordinators responsible for the care of larger buildings and non-residential building types (BCA Building Classes 2-9). It is styled to assist people through the decision making processes associated with implementing alternative water resource technologies, either as part of a site amenities review or as a stand-alone project.

1.2 How and When to use the guide

This guide is intended as an introduction to alternative water resource technologies, and as a tool for establishing whether such a technology is suitable for the particular organisation and circumstance under evaluation.

The guide can be useful from the moment the question of finding an alternative to urban water supply is raised, through the conceptual and decision making processes at the early stages of project formation. It does not attempt to provide all the answers, but rather gives information that can aid in feasibility discussions, and provide a basis for further investigation.

The first step for targeting reduced water use for any existing non-residential building is to undertake a water audit. This will identify the easily implemented water efficiency options available for the facility (further information on water audits is contained in section 2.4). Once the water efficiency program has been implemented, it is time to look at alternative water sources.

For new facilities an integrated water strategy should be specified as early as possible in the project, targeting both efficient water use and alternative water sources.

There are two main options for consideration when embarking upon an alternative water resource project:

- The first option is as a standalone project in response to the need to reduce reliance on centralised potable water supplies.

- The second option is to investigate alternative water supply as a side project to other new capital works or upgrade / refurbishment works. The advantages of this option can include reduced production downtime and combined costs for installation services.

Regardless of whether it is a stand-alone project or an extension of other works, a key learning from many urban sustainability projects, and one that can be carried across to alternative water resource projects, has been that sustainability concepts need to be considered early in the design phase of projects. This enables sustainability to be fully integrated into the other systems, and from a project management perspective,
embedded into the architecture of the project at a point when it will have the most influence at the least possible cost.

**Figure 1: Design influence (The importance of considering alternative water shortages early in the project)**

There are also a range of professional services that may be engaged for alternative water resource projects whose expertise and guidance overlap with project phases, from concept development through to detailed design and installation, to assure a range of information and support for each.
Figure 2: Guidance showing project phases, relevant guidance per project stage, and professional services that may be engaged at particular project phases.

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Guidance</th>
<th>Professional Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept development</td>
<td>SmartWater Non-residential Guide</td>
<td>Management</td>
</tr>
<tr>
<td>Concept feasibility &amp;</td>
<td></td>
<td>Discussions with EPHC/EPA</td>
</tr>
<tr>
<td>Design development</td>
<td></td>
<td>Plumber / engineering consultancy</td>
</tr>
<tr>
<td>Detailed design</td>
<td>Regulation and Standards…</td>
<td>Consultancy services</td>
</tr>
<tr>
<td>Installation</td>
<td>Other Guidance…</td>
<td></td>
</tr>
<tr>
<td>Reflection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other Guidance…
Regulation and Standards…
2 WATER RESOURCES IN AUSTRALIA

Of water consumed in Australia’s major cities, 21.2% is used by commercial and industrial users; and 6.7% by local government, parks and in fire fighting.

Table 1: Water use in Australia’s 22 Largest Cities [2]

<table>
<thead>
<tr>
<th>COMPONENT OF WATER USE</th>
<th>VOLUME ML</th>
<th>PERCENTAGE OF TOTAL CONSUMPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Residential</td>
<td>1,219,000</td>
<td>59.0%</td>
</tr>
<tr>
<td>Industrial and Commercial</td>
<td>437,000</td>
<td>21.2%</td>
</tr>
<tr>
<td>Local governments, parks, fire fighting</td>
<td>139,000</td>
<td>6.7%</td>
</tr>
<tr>
<td>System losses</td>
<td>221,000</td>
<td>10.7%</td>
</tr>
<tr>
<td>Customer meter errors</td>
<td>49,000</td>
<td>2.4%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,065,000</td>
<td>100%</td>
</tr>
</tbody>
</table>

At a residential level, much effort has been invested in educating consumers about water scarcity, and providing consumers with alternative options to reduce their water use. However, achieving the same goals in the commercial, industrial and institutional sectors requires a different approach due to the extremely diverse range of processes and uses of water employed across these areas.

The following table shows the breakdown of water end use for a number of different commercial / public building types. The data comes from a range of national and international sources but is limited in its accuracy. There are still gaps in the availability of reliable and detailed benchmarking studies in Australia for water use patterns in the different building types.
Figure 3: Water use in non-residential building types [65]

<table>
<thead>
<tr>
<th>BUILDING TYPE</th>
<th>SINKS / DISH RINSE</th>
<th>DISHWASHER</th>
<th>ICE MACHINE</th>
<th>KITCHEN</th>
<th>BASIN</th>
<th>TOILET / URINAL</th>
<th>RESTROOM</th>
<th>BATHROOM (EXCL SHOWERS)</th>
<th>SHOWER</th>
<th>LAUNDRY</th>
<th>CLEANING</th>
<th>COOLING TOWER</th>
<th>IRRIGATION</th>
<th>POOL</th>
<th>LOSSES</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shops Supermarket</td>
<td>0.5%</td>
<td>7%</td>
<td>7%</td>
<td>14%</td>
<td>60%</td>
<td>9%</td>
<td>14%</td>
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<td></td>
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</tr>
<tr>
<td>Sit Down Restaurant</td>
<td>35%</td>
<td>22%</td>
<td>8%</td>
<td>65%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td></td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast Food Restaurant</td>
<td>42%</td>
<td>6%</td>
<td>12%</td>
<td>60%</td>
<td>11%</td>
<td>11%</td>
<td>24%</td>
<td></td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Drive in Shopping Centres</td>
<td>0.5%</td>
<td>83%</td>
<td>83%</td>
<td>1%</td>
<td>11%</td>
<td>3%</td>
<td>2%</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motels</td>
<td>18%</td>
<td>4%</td>
<td>25%</td>
<td>29%</td>
<td>26%</td>
<td>17%</td>
<td>5%</td>
<td>3%</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td>16%</td>
<td>3%</td>
<td>23%</td>
<td>26%</td>
<td>23%</td>
<td>15%</td>
<td>5%</td>
<td>10%</td>
<td>3%</td>
<td>2%</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Education Kindergarten / Child Care</td>
<td>1%</td>
<td>63%</td>
<td>63%</td>
<td>36%</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Education Primary</td>
<td>1%</td>
<td>61%</td>
<td>61%</td>
<td>36%</td>
<td>2%</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Education Secondary</td>
<td>1%</td>
<td>4%</td>
<td>36%</td>
<td>40%</td>
<td>3%</td>
<td>53%</td>
<td>3%</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Education University / TAFE</td>
<td>2%</td>
<td>66%</td>
<td>66%</td>
<td>10%</td>
<td>11%</td>
<td>1%</td>
<td>10%</td>
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</tr>
<tr>
<td>Commercial Office</td>
<td>2%</td>
<td>50%</td>
<td>50%</td>
<td>40%</td>
<td>1%</td>
<td></td>
<td>7%</td>
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<td></td>
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<tr>
<td>Hotel (Pub) / Tavern</td>
<td>33%</td>
<td>32%</td>
<td>32%</td>
<td>18%</td>
<td>4%</td>
<td>4%</td>
<td>9%</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Welfare Homes Institutions</td>
<td>10%</td>
<td>48%</td>
<td>48%</td>
<td>12%</td>
<td>15%</td>
<td>6%</td>
<td>9%</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital / Convalescent Home</td>
<td>8%</td>
<td>40%</td>
<td>40%</td>
<td>10%</td>
<td>13%</td>
<td>5%</td>
<td>24%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Swim Centres</td>
<td>0%</td>
<td>19%</td>
<td>25%</td>
<td>45%</td>
<td>10%</td>
<td>1%</td>
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</table>

2.1 Drought and Climate Change

Australia is the driest inhabited land mass in the world with 80% of the land having rainfall less than 600 millimetres per year and 50% having even less than 300 millimetres [3]. As illustrated, Victoria typically experiences wet winter and low summer rainfall [4]. Also illustrated below in beige are large areas of arid land. These arid areas are called the subtropics, and are dominated by high pressure (dry) weather patterns.
When planning an alternative water resource, future climate modelling may need to be considered in order to maximise benefits from the spending associated with these projects.

A report by James Cook University (JCU) bringing together a synthesis of 70 climate studies showed that the world’s tropical zones are expanding, and pushing the subtropical arid zone further south [61]. The study shows that the climate zones have moved between 300 and 533 km south and that they will move this far again over the next 25 years. This means that less rainfall can be expected for Southern Australia over time. Given that this is currently taking place, and will continue to do so over the next 50-100 years, it impacts directly on Victorian water replenishment and availability, making alternative water resource use a priority for forward-thinking non-residential users [60].

In Australia there are also going to be exceptional years of La Nina fed flooding, however, these should not distract from longer term climatic trends.

The following image illustrates the effect of this drying process appears to be having in Victoria. The image shows the rainfall deficiencies that have occurred over the last three years prior to this guide being published (image source: the Australian Bureau of Meteorology).
Sustained rainfall deficiency leading to the depletion of water reservoirs sees increasing restrictions on the use of potable water from catchments in cities. While the practical and economic effects of decreased rainfall are relatively easy to see, another significant impact relating to drought arises from the lowering of the water table. This means that when it rains, the water is absorbed by the natural environment and water table, in an attempt to replenish depleted stores, resulting in reduced runoff to established storage systems and less water for metropolitan use.

With an increasing population and with much of Australia receiving low average rainfall levels, the efficient use of existing water and the creation of alternative water resources is extremely important. Some examples of the ways Australia’s climate is currently in the process of changing are [6-9]:

- Longer droughts, dryer soils, lower groundwater tables;
- Increased severity of floods and storms;
- Fewer frosts in coastal areas, more fronts inland due to low humidity;
- Rising level of seawater (already 10-20cm since 1900);
- Increased temperature of water bodies, higher evaporation levels;
- Less snow; and
- Greatly increased bushfire size and intensity (as demonstrated in 2006 and 2009).
Figure 7: Melbourne’s main water reservoir the Thomson Dam has had its water level drop drastically over the past decade (Source: Melbourne Water).

2.2 Water and the built environment

The water cycle — or hydrologic cycle — is the continuous circulation of water within the Earth's hydrosphere, and is driven by solar radiation. This includes the atmosphere, land, surface water and groundwater. As water moves through the cycle, it changes state between liquid, solid, and gas phases. Water moves from compartment to compartment, such as from river to ocean, by the physical processes of evaporation, precipitation, infiltration, runoff, and subsurface flow.

The built environment has many effects on the natural water cycle. Large areas of impervious surfaces create stormwater runoff, rather than allowing water to soak into the ground to replenish water table levels. [10]. Impervious surfaces also increase the peak stormwater flows leaving the site, causing scouring, flooding and other consequences
downstream. When water is channelled directly into conventional stormwater drains, the local ecology and groundwater flows are disrupted.

Urban water use can also be highly inefficient. Urban water users generally take potable (drinking) water pumped in from offsite, utilise it (generally once), then dispose of it into the sewer system. [10]. As a society we need to be smarter about how water is used, and reusing water over again is likely to be a much more viable option to support sustainable water use across industries.

**Figure 8: Traditional urban water use**

In Melbourne most used water in non-residential buildings is treated via water treatment plants (Sewage treatment facilities) and then released into the sea. This treated sewage water is not of the same quality as water that is harvested through the natural water cycle. Built environments also currently cause water to be discharged back into the natural environment in specific places, which differ from the natural courses water would take, and which has further environmental ramifications [10].

### 2.3 **Integrated Urban Water Cycle**

“Capture water, use and reuse it wisely, release it with care”[60]

Water supply, sewerage, and stormwater can be integrated so that water is used optimally within a catchment and on a site. The use of Integrated Water Cycle Management (IWCM) promotes the coordinated planning, development and management
of water, land and related resources (including energy use). These are linked to urban areas and the application of sustainability principles within the built environment. IWCM works within the context of state and national policies, as well as local catchment plans. IWCM is sometimes also referred to as Total Water Cycle Management (TWCM) or Integrated Urban Water Management (IUWM).

Figure 9: Water management at different scales [21]

As planning becomes more localised, Water Sensitive Urban Design (WSUD) is used with a local scale and built environment focus. Water sensitive urban design seeks to improve stormwater runoff quality and reduce reliance on external catchments (dams and rivers). Urban and building design is integrated with catchment planning, management and conservation. This ensures that urban water management is sensitive to natural hydrological and ecological cycles. The key principles of WSUD are [21]:

- Protection of natural systems and enhancing biodiversity;
- Protecting stormwater quality;
- Protection of public health and sanitation;
- Reduction of demand on reticulated water systems;
- Treating and reusing water wherever practicable;
- Reducing treated effluent, and minimising wastewater;
- Adding value while minimising development costs;
- Local capture of water and detention of runoff;
- Recharging of aquifers;
- Functional and aesthetically pleasing landscaping; and
- Creating natural treatment systems with high ecological and social value.
Into this broader context fit Water Sensitive Buildings (Green Buildings). Water Sensitive Buildings use small-scale systems and tap into and relate with IWCM and WSUD systems.

For example, a Water Sensitive Building will capture and use rainwater, helping to reduce upstream water demand and downstream peak stormwater flows that causes scouring of local creeks.

**Figure 10: A Green Building that captures rainwater**

A Water Sensitive Building could also treat and reuse water, helping to reduce reliance on reticulated supplies and reducing sewage emissions. Such a building may also have onsite wetlands or rain gardens to filter stormwater runoff, reducing nitrogen, phosphorus and turbidity of the water leaving the site.

### 2.4 Conserving Water

As the impact of activities in the built environment on the natural water cycle becomes better understood, the incentive to change the way water is used becomes greater. In the non-residential sector there are significant opportunities to reduce reliance on centralised supply of potable water. The first step in protecting our limited fresh water resources must always be to reduce the level of consumption through water conservation measures. These measures include rectifying areas of waste through leaks and overflow, reducing flow rates, and reviewing processes to find areas where water is used beyond its absolute necessity. Once conservation strategies are in place, water reclamation, reuse, recycling, and alternative sourcing can be investigated.
A water audit should be carried out regularly to identify and cost water saving options. Water conservation is usually very cost effective, and also allows downsizing of the size and treatment requirements of alternative water source options. Examples of facilities that should undertake regular water audits include:

Commercial water users:

- Shops
- Shopping malls
- Car washes
- Distribution centres
- Depots
- Offices
- Entertainment centres

Industrial water users:

- Factories
- Warehouses
- Manufacturing facilities
- Scrap yards
- Power generation facilities

Institutional water users:

- Hospitals
- Universities
- Schools
- Nursing homes

2.5 Support for reducing water use

In 2004 the Victorian Government put in place a long-term plan for water - Our Water Our Future. Our Water Our Future sets out 110 initiatives for water conservation aimed at every sector of the community, seeking to provide water to sustain growth over the next 50 years. Its 110 actions aim to:

- Repair rivers and groundwater systems – the natural source of all fresh water – by giving them legal water rights and conducting restoration works;
- Price water to encourage people to use it more wisely;
- Permanently save water in our towns and cities, through common sense water saving and recycling measures;
• Secure water for farms through pioneering water allocation and trading systems; and

• Manage the water allocation to find the right balance between its economic, environmental and social values. [1]

The Victorian government’s *Our Water Our Future* plan was updated in 2008. The next stage of the government’s plan provides additional long-term solutions to secure water supplies by continuing projects such as the building of a desalination plant, saving water through upgrading irrigation channels, expanding the water grids around the state and extending conservation programs and water recycling. Water scarcity is a key challenge of climate change for Australia, and has been a driving force behind implementing water strategies.

The *Our Water Our Future* action plan is also driving the development of regional sustainable water strategies to plan for long-term water security throughout each region. Sustainable water strategy sits at a long-term regional plan to secure water for local growth while maintaining the balance of the area’s water system, and safeguarding the future of its rivers and other natural water resources.

**Figure 11: Victoria’s water strategy regions (Image source www.ourwater.vic.gov)**

Each sustainable water strategy provides a stock-take of all the water resources available within a region, and outlines the planning and actions needed to respond to risks. The aims are to ensure a secure water supply to communities, business, industry and the environment into the future. The strategies are developed by the Department of Sustainability and Environment in partnership with rural and urban water corporations, catchment management authorities, and other key regional stakeholders, interest groups, and communities.

In Melbourne, industry and commerce account for one third of drinking water supplied [1]. The top 200 water users account for 10% of the cities drinking supply [1]. Water consumption for large water users in this sector is being addressed through programmes
such as “WaterMAP” and “Environmental Resource Efficiency Plans”. These programs are discussed in more detail in the following sections.

2.5.1 WaterMAP

WaterMAP builds on prior successes achieved with the Victorian Government engagement program ‘Pathways to Sustainability’, that targeted water efficiency in the top 200 water users. Participation in the WaterMAP program is compulsory for water users consuming 10 mega-litres or more per annum from an urban water supply. They are obliged to identify potential improvements, and encouraged to implement as many of them as is practical.

WaterMAP does not specifically address the potential of alternative water resources, however it mentions these in some examples – such as the use of rainwater to reduce water use from the urban supply.

According to City West Water, participating organisations are assisted in achieving multiple benefits including reduced water supply and discharge costs, improved understanding of water use within their organisation, and access to funding to carry out initiatives. The program provides:

- Access to skilled and knowledgeable service providers
- Support material for use by customers and service providers
- Education and training
- Funding assistance
- Industry-specific benchmarks
- Monitoring
- Ongoing support
- Water Conservation Solutions Handbook Worksheets - [Editable Word Documents]

In general terms, most water retailers provide varying degrees of assistance with the implementation of WaterMAPs, and further information about this program can be found on their websites.

2.5.2 Environmental Resource Efficiency Plans (EREP)

EPA Victoria has implemented the EREP program which builds upon prior successes associated with energy consumption under the ‘EPA Industry Greenhouse Program’. EREP focuses on energy and water use and is compulsory for businesses consuming more than 100 tera-joules of energy per year and/or 120 mega-litres of water per year [11].

Like the WaterMAP program, EREP requires an analysis of consumption, target setting and the identification of savings measures, however there is one significant difference: under EREP, actions identified must be with a payback period of three years or less must be implemented [12].
Another difference between the programs is that the EREP considers not only urban water supplied to a site, but also water extracted from ground sources and recycled water supplied to the site, so that water reduction activities must address all of these water sources.

Contact EPA Victoria for more information.

2.6 Alternative Water Resources

Once the options for reducing water use and eliminating waste are implemented, the next option for reducing potable water consumption is to consider an alternative water resource. This is simply water that arises from a source other than centralised potable town water. The remainder of this guide defines the options for alternative water resources and explains how to evaluate the feasibility of such a system in non-residential situations.

Figure 12: Alternative water resources [60] - Only the more established water sources are covered in this guide, however innovative solutions should always be considered.
3 IS AN ALTERNATIVE WATER RESOURCE RIGHT FOR YOUR ORGANISATION?

There are several considerations to take into account when planning an alternative water resource for a non-residential situation. The following questions might be contemplated:

- What is the organisation’s environmental vision, strategy and targets?
- Which alternative water resource system would best suit your needs?
- Is the proposed system technically feasible?
- Does the water provided by the proposed system meet the appropriate health and safety standards for its application?
- How are the ongoing operational requirements able to be met?
- Given current and projected tariffs for water, interest rates and electricity, what are the financial savings generated by this technology?
- How much will the technology reduce the organisation’s water, energy and greenhouse gas emissions, and does this meet the company’s environmental targets?
- Are there other environmental implications – such as waste by-products or terrestrial, atmospheric or aquatic contamination issues?
- Are there any other social or political benefits or risks that might need to be evaluated?

3.1 What is an alternative water resource?

An alternative water resource is a supply of water other than the main urban fresh-water supply. The following core alternative water resources are considered in this guide, which can either be used ‘as is’ or treated to achieve a desired quality level.

**Rainwater** – water collected directly from roof run-off.

**Stormwater** – Untreated rainfall run-off from urban areas, ie: carparks, lawns, roads etc.

**Wastewater** – Water that has been used and would otherwise be disposed of. Examples may include discharge water from an industrial process, water from domestic sinks, basins, and kitchens (greywater), or sewage water (blackwater).

This water is then reused or recycled, as defined below:

**Reused Water** – Water taken from a waste stream that is used in a subsequent application without treatment.

**Recycled Water** – Water taken from a waste stream and then processed to improve quality before use in a subsequent application.

**Bore Water** – Only considered alternative by this guide if the aquifer can be sustainably utilised. This means that groundwater recharge must compensate for groundwater extraction.
Examples of technologies that can take advantage of these water resources are explained in detail in section 4.2 of this Guide.

**Figure 13: Example Water Sensitive Building with rainwater harvesting and wastewater treatment plant**

Water sources excluded from the above diagram include surface water extraction (rivers and lakes) and some ground water extraction (bore water). Where these sources rely on existing or limited environmental water flows they are not considered ‘alternative’ by this guide.

### 3.2 Why consider an Alternative Water Resource?

There are many different reasons to seek alternative water resources in non-residential applications. City West Water list some of the most prominent reasons for improving water efficiency on their website, and it is reasonable to assume that these are also applicable to using alternative water resources. The following reasons are among those cited [13]:

- Improved bottom line
- Reduced water consumption costs
- Reduced sewage discharge costs
- Reduced water and wastewater treatment costs
- Funding assistance to investigate and carry out water efficiency measures, the extent of which varies across water retailers. Funding is available periodically from other government sources.
- Reduced energy costs and greenhouse emissions
• Improved company reputation by reducing the impact of your business on the environment
• Behavioural change of staff and general users, leading to a further commitment to reduce water consumption
• A better understanding of how water is used within your business

3.2.1 Reducing business costs

For business, alternative water resources can provide an effective mechanism for reducing potable water related costs. Use of alternative water resources may also reduce water leaving the facility as trade waste and sewage, reducing water discharge fees.

These savings will continue to increase as the cost of water increases. As supplies of water fall in various areas it may be that pricing will increase, making alternative water source projects even more appealing [14].

For water supply companies exposed to externalities, alternative water resources present more compelling economic benefits. Studies in the UK have shown that water treatment costs are significantly lower than costs associated with water supplies such as desalination [15].

The process of quantifying these savings for a specific business is shown in detail in Section 5.2 of this report. The AWR PDA Tool also assists in this process.

3.2.2 Security of Supply and Pricing

Alternative water resources may also lead to a more secure water supply in times where restrictions apply, helping to ensure ongoing operations.

When weighing up options for water supply, the total cost will be influenced by several factors: the cost of water over the building life, the potential cost of providing back-up if the supply fails, the threat of the supply being interrupted either temporarily or permanently and the cost of public perception (Figure 14).

Figure 14: Factors considered when evaluating the security of a water supply

$\text{Cost of supply over the life of the building} + \text{Cost of providing back-up} \times \text{Threat of interruption} + \text{Cost of public perception}$

The severity of a threat to a water supply is influenced by:
• The local climate and the supply dependence on the climate
- The capacity and age of local infrastructure
- The risk of extreme events such as drought and floods
- The risk of security threats
- And the degree of contingencies hardwired into the infrastructure.

The higher the threat level, the lower the security of supply and the more attractive recycled water options become. If the supply security is low, public perception is also likely to play a role, with larger users and organisations expected to display social responsibility and regional equity in their use of water.

When the security of supply is a factor in considering an onsite alternative water resource, the reliability of the onsite system becomes more critical to decision makers. One of the most common threats to supply security in Australia is climate, and hence the reliability of an alternative water source in extreme climate conditions is one of the most important factors to consider. Climate dependant supplies, such as rainwater are less favourable than more reliable sources such as blackwater in these circumstances.

Table 2: Security of recycled water supplies as related to potential climate impacts.

<table>
<thead>
<tr>
<th>Immediate climate impacts</th>
<th>Longer term climate impacts</th>
<th>Not climate dependant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low supply security</td>
<td>Medium supply security</td>
<td>High supply security</td>
</tr>
<tr>
<td>Rainwater Tanks</td>
<td>Bore Water / Bulk (irrigation) Water</td>
<td>Greywater Treatment / Reuse</td>
</tr>
<tr>
<td>Stormwater capture and reuse including mechanical or wetland (WSUD) treatment</td>
<td>Groundwater Desalination</td>
<td>Blackwater Treatment and recycling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seawater Desalination</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sewer mining</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other onsite recycling</td>
</tr>
</tbody>
</table>

CASE STUDY: Security of Supply

The Bendigo Bank recently built a new headquarters building in Bendigo. As with many Australian cities, Bendigo has a drought vulnerable water supply and often experiences extreme water shortages and restrictions. The Bendigo Bank headquarters building would have been the largest single water user in town. Consequently, to reduce water demand on the town water supply, and to improve operational reliability, several alternative water source technologies were introduced. This includes the installation of a Recycling Water Treatment Plant (RWTP). The result was 20,000 litres of wastewater treated per day,
saving around 4.5 million litres of drinking water annually. It also ensures that the
Bendigo Bank’s headquarters can continue operating even in the event of the town’s
water supply failing.

Figure 15: The Bendigo Bank Centre in Bendigo, VIC

3.2.3 Corporate Social Responsibility

Many organisations are now making firm commitments to sustainability principles. This is
driven by increasing employee and stakeholder environmental awareness, and increasing
public and government expectations of how an organisation will operate.

This may include regularly publicly reporting on activities in the area of corporate social
responsibility and environmental performance. Corporate Social Responsibility (CSR) is a
key driver when considering alternative water resource projects.

For example in the Bendigo Bank building, further water savings are made through
collecting rainwater in a 10,000 litre roof-top tank. Rainwater is used in the drip-fed
irrigation system that supplies the extensive native landscaped gardens around the
building. This enhances the Bendigo streetscape and improves public amenity, while
sustainably giving the building a ‘lush’ feel in the middle of a drought stricken community.

The reputations of businesses and institutions are also derived from consistency with
social, ethical and cultural norms. Reflecting social expectations in business/institution
practice enhances reputation, and as customers and clients are increasingly searching
for environmentally friendly products and services, so conserving water through reuse
and collection can help to act to attract potential customers and clients.
3.3 What are the applications for alternative water use?

The potential applications for alternative water resources vary considerably between the various types identified. For untreated resources (rainwater, stormwater and waste stream reuse) the quality of the resource is defined by the quality of the source. For a treated stream, quality could vary across a range depending on both the quality of the source and the treatment systems in place.

Table 3: Applications in which alternative water sources can be reused [16].

<table>
<thead>
<tr>
<th>Building Uses</th>
<th>Industrial Applications</th>
<th>Non Industrial Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilet flushing</td>
<td>Material washing</td>
<td>Crop irrigation (surface and subsurface)</td>
</tr>
<tr>
<td>Heating/cooling (air-conditioning) systems</td>
<td>Process rinse water</td>
<td>Constructed wetland and lake top-up</td>
</tr>
<tr>
<td>Landscape irrigation (surface and subsurface)</td>
<td>Crate and pallet washing</td>
<td>Construction</td>
</tr>
<tr>
<td>Outdoor use: washing cars, outdoor surfaces, outdoor recreation, and use in water features</td>
<td>Hardstand and vehicle washing</td>
<td>Dust suppression</td>
</tr>
<tr>
<td>Washing machine (with dedicated washing machine taps)</td>
<td>Industrial fire protection</td>
<td>Environmental Flows</td>
</tr>
<tr>
<td>Fire protection</td>
<td>Cooling</td>
<td>Groundwater recharge</td>
</tr>
<tr>
<td>Boiler or cooling tower feed water supplement</td>
<td>Boiler or cooling tower feed water supplement</td>
<td>Stock Watering</td>
</tr>
</tbody>
</table>

3.4 Occupational Health and Safety

As with most major projects, alongside the clear benefits of alternative water resources lie inherent risks.

Accordingly, public perception can be a positive when viewed in terms of actions toward protection of the environment, but it has been shown that many still hold reservations about using recycled water. Past projects have been known to fail due to lack of acceptance by the public or other end user group, often at the last moment. A recent study by the CSIRO found that emotion had a much greater influence on acceptance of recycled water products than did knowledge or fact. Trust in the authorities and organisations, or lack thereof, was amongst the highest influencing factors when it came to public acceptance. [17]

For further information about risk assessment refer to Sections 4.1.3 through to 4.1.5 of this guide.
3.5 Water Quality Issues

Water quality issues for the various water sources and applications are outlined in the next section, including explanation of water quality issues for specific alternative water sources.
4 CHOOSING THE RIGHT ALTERNATIVE WATER RESOURCE

Selecting the right alternative water resource and associated technology for the specific application being considered is undoubtedly important. To do so, it is important to understand the application thoroughly, only then can the water source and treatment process be known to be fit for the purpose.

4.1 Understanding quality requirements

This section outlines some of the information required to understand water quality issues in alternative water resources. Water quality requirements depend on the source of the alternative water resource and the intended end-use of the water. A proper understanding of the purpose for which the water is to be used is therefore an essential first step in selecting a source of alternative water supply and associated treatment technology, firstly to establish which options are suitable from a functional perspective, and also to help identify risks and regulation requirements.

4.1.1 Water quality based on source of water

The source of the water (e.g. rainwater, stormwater), combined with the type of technology used to reclaim and process this water will have implications on the final quality of the water. The quality, availability, and range of uses of alternative water sources are discussed in this section. It should be noted that further uses are available for each water type depending on the treatment options applied.

Water qualities expected from urban sources are summarised in Table 4. The summary does not directly reference the alternative resources above, however it gives a guide as to the quality expected from each and the need for treatment or otherwise.
### Table 4: Summary of water qualities for urban streams [18]

<table>
<thead>
<tr>
<th>WATER</th>
<th>SOURCE</th>
<th>QUALITY</th>
<th>TREATMENT REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable mains water</td>
<td>Reticulated (pipes) water distribution</td>
<td>High quality</td>
<td>Low requirements. End user filtration in areas of poor palatability.</td>
</tr>
<tr>
<td>Roof run-off</td>
<td>From roof during rain, generally stored in rainwater tank</td>
<td>Reasonable quality</td>
<td>Low. Sedimentation can occur inside rainwater tanks. Filtration and UV sterilisation preferable if used for drinking or other sensitive uses.</td>
</tr>
<tr>
<td>Stormwater run-off</td>
<td>Catchment run-off, including impervious areas like roads pavements</td>
<td>Moderate quality – (however this may vary depending on the region)</td>
<td>Reasonable treatment needed to remove litter and reduce sediment and nutrient loading.</td>
</tr>
<tr>
<td>‘Light’ greywater</td>
<td>Shower, bath, bathroom basins</td>
<td>Cleanest wastewater – low pathogens and low organic content</td>
<td>Moderate treatment – required to reduce pathogens and organic content.</td>
</tr>
<tr>
<td>Greywater</td>
<td>Light greywater, laundry water, including basin and washing machine</td>
<td>Low quality – high organic loading and highly variable depending on how it was used</td>
<td>High level of treatment. High organic loading and highly variable quality.</td>
</tr>
<tr>
<td>Blackwater</td>
<td>Kitchen, toilet and bidet water</td>
<td>Lowest quality – high levels of pathogens and organics</td>
<td>Advanced treatment and disinfection required.</td>
</tr>
</tbody>
</table>

### 4.1.2 Water quality based on use

In the past water has been classified under a system of grading, judged by the potential impact on human health.

There are different grading standards used depending on the scale and complexity of the water treatment systems being used.

For smaller systems the water quality standards in Table 5 are used. These standards are used as the testing for them is relatively simple. These standards should not be used for industrial operation related effluents and not with complex effluents such as commercial trade waste.
### Table 5: Summary of water qualities for urban streams [63]

<table>
<thead>
<tr>
<th>WATER QUALITY STANDARD</th>
<th>EFFLUENT QUALITY</th>
<th>USES</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/10/10 standard</td>
<td>&lt;10 mg/L BOD5, &lt;10 mg/L suspended solids and E.coli &lt;10 cfu/100 mL</td>
<td>Greywater of this quality may be recycled indoors via toilet flushing or cold-water supply to washing machines. It may also be used for surface and subsurface irrigation.</td>
</tr>
<tr>
<td>20/30 standard</td>
<td>&lt;20 mg/L BOD5 and &lt;30 mg/L suspended solids</td>
<td>Wastewater including greywater of this quality may be recycled outdoors via subsurface irrigation.</td>
</tr>
<tr>
<td>20/30/10 standard</td>
<td>&lt;20 mg/L BOD5, &lt;30 mg/L suspended solids and E.coli &lt;10 cfu/100 mL</td>
<td>Wastewater including greywater of this quality may be recycled outdoors via surface and subsurface irrigation.</td>
</tr>
</tbody>
</table>

The above standards are outlined in the Victorian EPA’s publication 891.1, *Code of practice — Onsite wastewater management*. This Code applies to all types of onsite systems treating up to 5000 litres of wastewater per day. These treatment systems plus the associated disposal/recycling systems (i.e., land disposal, outdoor recycling and/or indoor recycling) are referred to as ‘septic tank systems’ in the Environment Protection Act 1970.

For larger systems over 5000 litres per day, effluent water is given a grade from A to D, depending on the water quality target parameters being achieved. For guidance on larger systems see EPA’s publication 500, *Code of Practice for Small Wastewater Treatment Plants*.

More complex water standards, as outlined in Table 6, have been prepared with a primary goal of addressing risks to human health and the environment.
Table 6: Summary of Water Classifications and Treatment [19]

<table>
<thead>
<tr>
<th>CLASS</th>
<th>WATER QUALITY OBJECTIVES – MEDIAN UNLESS SPECIFIED</th>
<th>TREATMENT PROCESSES</th>
<th>RANGE OF USES - USES INCLUDE ALL LOWER CLASSES</th>
</tr>
</thead>
</table>
| A     | Indicative objectives  
<10 E. coli org/100 mL  
Turbidity <2 NTU  
<10/5 mg/L BOD/SS  
pH 6-9  
1 mg/L Cl residual (or equivalent disinfection) | Tertiary and pathogen reduction with sufficient log reductions to achieve:  
<10 E. coli per 100 mL;  
<1 helminth per litre;  
<1 protozoa per 50 litres; &  
<1 virus per 50 litres. | Urban (non-potable): with uncontrolled public access  
Agricultural: eg human food crops consumed raw  
Industrial: open systems with worker exposure potential |
| B     | <100 E. coli org/100 mL  
Ph 6-9  
<20/30 mg/L BOD/SS | Secondary and pathogen (including Helminth reduction for cattle grazing) reduction | Agricultural: eg dairy cattle grazing  
Industrial: eg wash-down water |
| C     | <1000 E. coli org/100 mL  
Ph 6-9  
<20/30 mg/L BOD/SS | Secondary and pathogen (including Helminth reduction for cattle grazing) reduction | Urban (non-potable): with controlled public access  
Agricultural: eg human food crops cooked/processed, grazing/fodder for livestock  
Industrial: systems with no potential worker exposure |
| D     | <10000 E. coli org/100 mL  
Ph 6-9  
<20/30 mg/L BOD/SS | Secondary | Agricultural: non-food crops including instant turf, woodlots, flowers |

A useful reference point for risk assessments is presented in the Victorian EPA’s ‘A Framework for Alternative Urban Water Supplies’ [20], which describes risk levels associated with various water collection and treatment processes. Although geared toward water recycled from sewage, the document sets out guidelines for the treatment and use of recycled water, risks and responsibilities associated with treated water use, monitoring and reporting as well as providing information about the environmental benefits of water recycling [19]. The Victorian Department of Health have released draft guidelines for the validating treatment processes for the reduction of pathogens in Class A recycled water [21]. As Table 6 shows, the guidelines indicate those elements that constitute the different classes of treated water, the way each water class is achieved and what the use of the water may be.
Table 7: Glossary of water quality terms [19].

<table>
<thead>
<tr>
<th>TERM</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>Biochemical oxygen demand - a measure of the amount of oxygen used in the biochemical oxidation of organic matter. The BOD test is typically conducted over a period of five days under specified conditions and may then also be referenced as BOD5.</td>
</tr>
<tr>
<td>E.coli</td>
<td>Escherichia coli. A bacterium found in the gut of warm blooded animals that indicates faecal contamination.</td>
</tr>
<tr>
<td>NTU</td>
<td>Nephelometric Turbidity Unit — unit of measure of the turbidity of water due to suspended, colloidal and particulate matter.</td>
</tr>
<tr>
<td>Pathogens</td>
<td>Organisms capable of causing disease. In untreated sewage, the key potential pathogens are bacteria, viruses, protozoans and helminths.</td>
</tr>
<tr>
<td>SS</td>
<td>Suspended Solids.</td>
</tr>
<tr>
<td>pH</td>
<td>The measure of the acidity and alkalinity of water.</td>
</tr>
</tbody>
</table>

The following points should be addressed to understand all possible applications for the water source being considered: (adapted from [22]).

<table>
<thead>
<tr>
<th>ALTERNATIVE WATER RESOURCE CHECKLIST</th>
<th>PROJECT SPECIFIC COMMENTS / NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection of end uses</td>
<td></td>
</tr>
<tr>
<td>What will the water be used for?</td>
<td></td>
</tr>
<tr>
<td>Map of the uses or processes to which this water will be applied</td>
<td></td>
</tr>
<tr>
<td>Decide what water quality will be required</td>
<td></td>
</tr>
<tr>
<td>Establish health risks &amp; requirements at each stage</td>
<td></td>
</tr>
<tr>
<td>Determine quantity and quality requirements</td>
<td></td>
</tr>
<tr>
<td>How much water do you need?</td>
<td></td>
</tr>
<tr>
<td>(Create a site water balance map - showing predicted volumes all the water supplies, balanced against end uses)</td>
<td></td>
</tr>
<tr>
<td>What is the level of potential human contact?</td>
<td></td>
</tr>
<tr>
<td>What are the requirements for any water released as stormwater?</td>
<td></td>
</tr>
<tr>
<td>What are the other chemical and mechanical criteria (eg: avoid scale)</td>
<td></td>
</tr>
<tr>
<td>ALTERNATIVE WATER RESOURCE CHECKLIST</td>
<td>PROJECT SPECIFIC COMMENTS / NOTES</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>build-up, salt concentrations, specific corrosion/erosion requirements etc.?</td>
<td></td>
</tr>
</tbody>
</table>

**Identify demand characteristics**

<table>
<thead>
<tr>
<th>Hourly/Weekly/Seasonal variations in supply and demand</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine reliability and requirements for mains top up</td>
<td></td>
</tr>
</tbody>
</table>

**Onsite detention provisions**

| Decide the size of the storages needed to best match up the supply with the demand, especially for variables like rainfall or seasonal irrigation demand. |                                  |

**Maintenance provisions**

<table>
<thead>
<tr>
<th>Decide what type and level of maintenance is required (manufacturer support, service schedules, monitoring)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensure life-cycle costs and maintenance responsibilities are understood</td>
<td></td>
</tr>
</tbody>
</table>

**External and on-flow considerations**

<table>
<thead>
<tr>
<th>What will happen to expended water and by-products, and how will this affect other downstream users?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Can water be used off-site or to enhance ecosystems?</td>
<td></td>
</tr>
<tr>
<td>Can the system be part of a larger integrated water management scheme?</td>
<td></td>
</tr>
</tbody>
</table>

The following issues should be investigated and managed if using an alternative water source for irrigation [64].
• **Concentration**: Increase in the amount or strength of hazards in recycled water, through evaporation.

• **Contamination**: Increasing concentrations of unwanted constituents in environmental end points (e.g. soils, plants, water bodies, biota, etc.).

• **Eutrophication**: Nutrient enrichment leading to increased productivity. Typically in the form of nitrates and phosphates, and most often from human sources such as agriculture, recycled water and urban runoff.

• **Loss of biodiversity**: Mortality of native biota resulting in reduced ecosystems, species or genetic diversity due to low level pollutants. For example many native species are highly sensitive to increased nutrient levels.

• **Nutrient imbalance**: Unbalanced supply of plant mineral nutrients resulting in plant deficiencies and toxicities.

• **Odours**: may decrease user or visitor amenity.

• **Pest and disease**: An insect or animal that destroys plants and an illness affecting plants, animals or other biota.

• **Salinity**: The presence of soluble salts in soils or waters. Electrical conductivity (EC) and total dissolved salts (TDS) are measures of salinity.

• **Sodicity**: Soil with excessive exchangeable sodium (ESP>6%), leading to poor soil structure.

• **Toxicity**: The extent to which a compound is capable of causing injury or death, especially by chemical means, to plants and other terrestrial or aquatic biota.

• **Waterlogging**: Saturation of soil with excess water.

There is a range of water quality issues that need to be considered for reusing water in industrial or commercial processes. Water reuse can affect the operation of commercial or industrial processes and require process parameters to be set to specify a specific water quality for a desired reuse. For example, reusing water in machinery that has high salt concentrations may cause accelerated corrosion, so a high sodium water stream would not be suitable for reuse in machinery.
Table 8: Some of the important process parameters, from [62]

<table>
<thead>
<tr>
<th>WATER QUALITY PARAMETER</th>
<th>NEGATIVE AFFECTS FOR PROCESSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual organics</td>
<td>Bacterial growth, microbial fouling, foaming in process water</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Forms combined chlorines with lower disinfection effectiveness, causes corrosion, promotes microbial growth</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>Scale formation, algal growth, bio-fouling of process equipment</td>
</tr>
<tr>
<td>Total suspended solids (TSS)</td>
<td>Deposition in materials, microbial growth, poor aesthetics</td>
</tr>
<tr>
<td>Sodium</td>
<td>Corrosion</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>Corrosion, scale formation, poor aesthetics</td>
</tr>
<tr>
<td>Dissolved minerals: calcium, magnesium, iron, and silica</td>
<td>Scale formation</td>
</tr>
</tbody>
</table>

As the approach illustrates in Figure 16 it is essential for an organisation to identify the end use application of the water derived from a water reuse and recycling project to ensure an appropriate risk assessment of the human health and environmental concerns are undertaken.

Figure 16: Recommended Industrial Water Scheme Assessment Process, from [16]
4.1.3 Risk

Any scheme which uses alternative water resources must consider public and environmental risk. A recent discussion paper released by the Victorian Government, Department of Sustainability and Environment and the Department of Human Services titled “A framework for Alternative Urban Water Supplies: Industrial Water” outlined the recommended approach to managing human health and environmental risk. This approach is aimed at water reuse in both the industrial and non-industrial sectors.

As part of efforts to encourage the use of alternative water resources, the Victorian Government commissioned a study that looked into the inherent risks of various alternative water resource types and assessed regulatory gaps that could be addressed. A useful aspect of the study was the assessment of inherent risks associated with a range of alternative water resources that was undertaken by an expert panel. Although conducted at a strategic level, the risk assessment provides a useful reference point for alternative water resources used in various applications, especially during the early stages of alternative water resource consideration.

Water from industrial waste streams that could be treated or reused are not included in the scope of the above risk assessment. Work is continuing in developing risk guidance for the use of these water streams. The EPA is currently in the process of updating published guidelines to incorporate a more risk based approach and has issued a discussion paper outlining key issues and possible future directions, with specific attention to potential alternative industrial water supplies [23].

4.1.4 Undertaking Risk Assessment

Risk management frameworks are an essential aspect of the decision making process when considering the use of an alternative water resource.
When a non-residential water user wishes use a large alternative water resource in preference to the reticulated drinking water supply, they begin to take on risks and associated responsibilities that are currently held by the water supply authorities. Quantification of ongoing risk is critical in allowing the non-residential agent to become comfortable with alternative water resources.

A key barrier to the uptake of alternative water resources can be concerns regarding legislative compliance, and potential risks to human health. Fortunately, numerous documents have been published that can provide guidance to those considering use of alternative water resources, including:

- Australian Guidelines for Water Recycling [25]
- Australian Drinking Water Guidelines [26]
- AS4360 Risk Management [24]
- Alternative Urban Water Supplies – Regulatory Review [27]

Risks of particular concern fall into the following categories:
Table 9: Health and environmental risks identified in published guidelines [19].

<table>
<thead>
<tr>
<th>ENVIRONMENTAL</th>
<th>HUMAN AND LIVESTOCK HEALTH</th>
<th>PRODUCE (FOOD) SAFETY</th>
<th>LEGAL LIABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid contamination of the air environment from the production of offensive odours, spray drift and aerosols</td>
<td>Reclaimed water use must not pose an unacceptable risk to humans, livestock and associated products</td>
<td>Reuse schemes must not result in the unacceptable microbial or chemical contamination of produce or food, or otherwise adversely affect produce quality</td>
<td>Liability may exist under the Trade Practices Act for the use of reclaimed water</td>
</tr>
<tr>
<td>Avoid structural changes to the soil or contamination</td>
<td>Protect beneficial uses of groundwater and surface water</td>
<td></td>
<td>Development of an alternative water supply scheme, whether it is for collecting rainwater from a roof or to treat industrial effluent, requires addressing risks in the above categories rigorously.</td>
</tr>
<tr>
<td>Protect beneficial uses of groundwater and surface water</td>
<td></td>
<td></td>
<td>Collect rainwater from a roof or to treat industrial effluent, requires addressing risks in the above categories rigorously</td>
</tr>
</tbody>
</table>

There are additional risks that may impact commercial, industrial and institutional applications, including:

- Continuity of treatment water supply - Reliability of flow from alternative water supply system
- Downstream infrastructure impacts - Potential for use of alternative water supply to cause machinery damage
- Financial - Potential for a system to generate unanticipated costs
- Reputation - Potential for a business’s reputation to be adversely affected

### 4.1.5 Risk Management Framework

A useful risk management technique is applied in the ‘Australian Drinking Water Guidelines’ [26] that can be extended to water supply more generally. The risk management approach prescribed draws distinctions between three key elements:

- **Hazard** – a biological, physical, chemical or radiological agent that has the potential to cause harm
- **Hazardous event** – an incident or situation that leads to the presence of a hazard
- **Risk** – likelihood of identified hazards causing harm” [26]

Risk management involves the identification of hazards and hazardous events, then the assessment of the likelihood of the event causing harm (the risk). Risk can be defined using the matrix described in the following table.
Table 10: Risk quantification matrix [26].

<table>
<thead>
<tr>
<th>LIKELIHOOD</th>
<th>1 Insignificant</th>
<th>2 Minor</th>
<th>3 Moderate</th>
<th>4 Major</th>
<th>5 Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (almost certain)</td>
<td>Moderate</td>
<td>High</td>
<td>Very high</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>B (likely)</td>
<td>Moderate</td>
<td>High</td>
<td>Very high</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>C (possible)</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>D (unlikely)</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>E (rare)</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

AS4360: Risk Management [24] describes this approach to risk management in more detail and is considered an appropriate method for determining areas of focus when designing an alternative water resource supply system. Having identified the risks associated with a water supply scheme it is possible to put in place appropriate counter measures and prioritise risk management activities.

The EPA is currently in the process of updating published guidelines to incorporate a more risk based approach and has issued a discussion paper outlining key issues and possible future directions, with specific attention to potential alternative industrial water supplies [23].

Table 11: Considerations for acceptable use of Class A water [28].

<table>
<thead>
<tr>
<th>Potential use</th>
<th>Environmental(^1)</th>
<th>Plumbing/communication(^3)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garden watering, including vegetables</td>
<td>Risk assessment</td>
<td>Controls required</td>
<td>–</td>
</tr>
<tr>
<td>Car washing</td>
<td>Avoid run-off to stormwater system</td>
<td>Controls required</td>
<td>–</td>
</tr>
<tr>
<td>General outdoor use (e.g., wash-down/construction)</td>
<td>Avoid run-off to stormwater system</td>
<td>Controls required</td>
<td>–</td>
</tr>
<tr>
<td>Ornamental ponds/water features</td>
<td>Management controls required</td>
<td>Controls required</td>
<td>Aesthetics</td>
</tr>
<tr>
<td>Toilet flushing</td>
<td>–</td>
<td>Controls required</td>
<td>Aesthetics</td>
</tr>
<tr>
<td>Washing machines(^4)</td>
<td>–</td>
<td>Controls required</td>
<td>Public acceptance, aesthetics</td>
</tr>
<tr>
<td>Commercial/industrial/municipal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>Risk assessment</td>
<td>Controls required</td>
<td>–</td>
</tr>
<tr>
<td>Construction</td>
<td>Avoid run-off to stormwater system</td>
<td>Controls required</td>
<td>–</td>
</tr>
<tr>
<td>Wash-down</td>
<td>Avoid run-off to stormwater system</td>
<td>Controls required</td>
<td>–</td>
</tr>
<tr>
<td>Dust suppression</td>
<td>Avoid run-off to stormwater system</td>
<td>Controls required</td>
<td>–</td>
</tr>
<tr>
<td>Cooling towers</td>
<td>–</td>
<td>Controls required</td>
<td>Legionella control(^6)</td>
</tr>
<tr>
<td>Toilet/urinal flushing</td>
<td>–</td>
<td>Controls required</td>
<td>Aesthetics</td>
</tr>
<tr>
<td>Fire protection systems/hydrants</td>
<td>–</td>
<td>Controls required</td>
<td>–</td>
</tr>
</tbody>
</table>

Importantly, it should be recognised that guides produced by regulatory agencies tend to (quite rightly) focus on mitigating risks associated with the environment and human health. Risks exist beyond the environmental and human health for commercial, industrial
and institutional water users considering alternative water sources. These additional risks should be incorporated by ensuring a rigorous risk management exercise is undertaken and acted upon (as described above).

### 4.2 Water treatment technologies

Water treatment systems vary depending on the size and the intended application. Treatment can be as simple as a domestic greywater system all the way up to a major engineered wastewater treatment plant. This chapter will outline some of the types and stages of wastewater treatment.

**Figure 18: The Bendigo Bank Building Wastewater Treatment Plant incorporating all three stages of water treatment (image courtesy of Sustainability Victoria and the Bendigo Bank)**

The Bendigo Bank plant in Figure 18 treats both grey and blackwater, and provides treated Class A water for use in toilet flushing. The Recycled Water Treatment Plant (RWTP) uses a three-stage process whereby water is mechanically filtered then biologically treated before being disinfected and stored in a 10,000 litre tank. No water from the reticulated supply is used for toilet flushing.

Treatment of water from alternative water resources is undertaken to enhance the water quality for use in other applications. There are several stages that can be applied to a water treatment system. Inclusion or exclusion of stages depends on the qualities of the water to be treated by the system and the qualities required of the treated water generated. Depending on these requirements a treatment system may include some or all of the stages described below.

**Figure 19: Stages in wastewater treatment (not all are required in all applications)**
There are many different wastewater treatment technologies available for each stage of treatment. Technologies for each treatment stage range in specifications such as the systems treatment capabilities, cost, maintenance, labour requirements and size.

Primary treatment involves the removal of sand, grit, solids, oils, grease, fats and other settled materials from the water stream through the use of screening and sedimentation systems.

Primary treatment often utilises mechanical treatment technologies such as:

- Mesh or strainers to remove the large objects;
- Sand channels, where the velocity of the incoming wastewater is slowed to allow for the settling of sand and grit for removal;
- Grease Traps and sedimentation tanks which remove floating oils, greases and fats as well as settled smaller particulates.
- It can also involve chemical dosing with a flocculent.

The Secondary treatment stage involves the removal of biological content such as human waste, food waste, and detergents from the wastewater stream often through the use of fixed film or suspended growth systems.

Secondary treatments utilise biochemical technologies such as activated sludge systems, rotating biological contactors and sequencing batch reactors to reduce BOD, nutrients and pathogens..

The Tertiary treatment stage usually involves the removal of residual toxins, and nutrients such as phosphorus and nitrogen through the use of filtration systems, lagoons and constructed wetlands. However; if the treated wastewater is to be used where there may be the risk of direct human contact, a disinfection stage is added to substantially reduce the number of pathogens still present in the water. Tertiary treatment can also involve the removal of salts. Disinfection involves the use of chlorination, ultraviolet (UV) light or ozone (O₃) but is not always required, depending on other treatments used.

Tertiary treatment is the additional treatment required to remove suspended or dissolved substances after secondary treatment has been completed [29]. Tertiary treatment can use technologies such as membrane filtration or reverse osmosis. An overview of secondary treatment technologies that could be applied in an alternative water resource system is described in Appendix B.

### 4.2.1 Treatment Technology Components

There are a range of larger scale treatment technologies available for treating wastewater. These are outlined briefly in this guide as some of the technologies are relevant to the allotment scale wastewater treatment plants. Further specialist project scoping advice should be consulted if the site requires a large scale custom built
wastewater treatment plant (see the list of water treatment consultants at the end of this guide).

4.2.2 Primary & Secondary Treatment Technologies

Activated Sludge

Activated Sludge is a biological treatment process that uses micro-organisms to stabilise a waste aerobically [29]. The process involves the mixture of primary effluent which settles solids from the settling tank to create a sludge mix. The production of an activated mass of micro-organisms acts to reduce the biological oxygen demand of the wastewater [30]. This stabilisation and treatment of the water is achieved aerobically by typically using lagoons and machines to create a vigorous aeration process or by injecting compressed air into the sludge mix (Figure 20). After this aeration process the wastewater enters a settling tank where the treated water is separated from the sludge. The sludge is then sent off for further treatment or used again at the start of the process and mixed in with the primary wastewater to start the biological treatment process again [29].

Figure 20: Activated sludge flow diagram.

![Activated Sludge Flow Diagram](image)

Worm Farms (vermiculture)

Other systems available for on-site treatment of blackwater involve using a simulated soil matrix (worm farm) to break down sewage and household organic waste - an on-site in-ground tank, containing a fully aerobic, humic biological filtration matrix, which also incorporates extensive vermiculture (worm) activity for the accelerated decomposition of organics. The cleaned water from these biological filtration matrix systems can then be reused on site or the effluent can be exported to a pressurised reticulation network.

Benefits of these systems:

- Cuts electricity costs around 90% compared to aerated treatment systems

† Melbourne Water’s activated sludge plants use a combination of aerobic and anoxic zones to reduce ammonia levels in the final discharge.
- Low maintenance, requires 1 service p.a. – many others need 3 or 4
- No odours; it has no septic stage, which can often smell
- Low noise
- Handles extra visitors and heavy loads
- Small system footprint

**Figure 21: Sewage entering vermiculture treatment system (source: Biolytix www.biolytix.com.au)**

**Aerated Lagoons**

Aerated Lagoon treatment involves the sequential use of large, shallow lagoons through which the wastewater flows, and like the Activated Sludge process uses micro-organisms to reduce the biological oxygen demand of the wastewater. Aerated Lagoons are typically able to reduce two thirds to one half of the biological oxygen demand of wastewater passing through them, depending on detention time [29]. The lagoons are aerated using large floating aerators which introduce turbulence within the lagoon, mixing the wastewater and providing oxygen throughout the liquid volume. The key difference between Aerated Lagoon treatment and Activated Sludge is that Aerated Lagoons are a continuous flow process that does not require the feedback of sludge to start the bacterial treatment process [31].
Aerated Lagoon effluent often contains a large proportion of suspended solids and consequently a high value of insoluble biological oxygen demand. Treatment is therefore usually followed by a settling pond process that removes suspended solids. Settling ponds usually consist of large, shallow, earthen basins where effluent from the Aerated Lagoons is detailed for a period of 6 to 12 hours [29]. Solids collected in the lagoons are removed from sedimentation ponds periodically as they reach capacity.

**Sequencing Batch Reactor**

This is a ‘fill-and-draw’ activated-sludge treatment system where the wastewater is added to the reactor. The reaction then takes place and the solids allowed to separate and settle, creating a cleaner effluent on top [29]. The Sequencing Batch Reactor (SBR) is suited to treatment of wastewater which has low or intermittent flow conditions and to areas of restricted land area.
Trickling Filters

Trickling filters are made up of a medium to which a biological layer adheres and grows. Media can consist of broken rocks, slag, plastic baffles or other structures. Water to be treated is ‘trickled’ over the media by a distribution system and exits the filter from the base via an underdrain system. The underdrain system provides a means for water to exit and for oxygen to enter the filter. In a modern trickle filter flow rate through the system and organic loading are adjusted to maintain an even biological layer on the media [29].

Although trickling filters are often designed for large scale applications, they can also be used in small scale applications. The Centre for Education and Research in Environmental Strategies (CERES), have installed such a small scale trickling filter to treat wastewater from their café operations (refer Figure 24).
4.2.3 Tertiary treatment technologies

Membrane filtration

Membrane filtration involves the passing of a known volume of water through a membrane filter which, due to its small pore size, filters out all the bacteria and other solids. Different techniques based upon pore sizes are: microfiltration (pores <0.2µm), ultrafiltration (pores 0.03-0.1µm), nano-filtration and reverse osmosis (separation determined by charge or molecular weight) [30]. Microfiltration is often used in smaller water supply systems due to the steady decline in the cost of membrane systems and reliability of the technology [34]. An example of the system in operation is illustrated in Figure 25.
Reverse osmosis

Reverse osmosis is a similar treatment process to membrane filtration in that it involves forcing water to be treated through a membrane at pressure. The membrane used is semi-permeable, meaning it will only allow water without the dissolved contaminant to pass through. In order to achieve the flow of treatment water through the membrane, pressure that exceeds the osmotic pressure needs to be exceeded. Osmotic pressure is caused by the natural tendency of uncontaminated water to move to the contaminated (containing a dissolved contaminant) side of the semi-permeable membrane [31]. The basic components of a reverse osmosis unit are the same as those used for membrane filtration: membrane, membrane support structure, a containing vessel and a high pressure pump [29].

Solar Stills

Solar stills mimic the process where the water from the oceans evaporates, condenses, and falls as rain [60]. Solar stills effectively eliminate water borne pathogens, salts, minerals and heavy metals Water used in a still could be from poorer quality water sources such as seawater, saline bore water, or recycled water. As water evaporates from the solar still basin, salts and other contaminants are left behind.

The operation of the still requires approximately three times as much make-up water as the distillate produced each day. Solar still production is a function of solar energy (insolation) and ambient temperature. Production rate in mid and southern Australian latitudes would average approximately 0.8 litres per square meter, per sun hour (About 1 kilo-litre/annum/m²).

Although this is a relatively low volume, the process is close to carbon neutral and the water is usually of sufficiently high quality to provide drinking water or other sensitive uses.
Disinfection technologies

Disinfection is only required if target pathogen levels are exceeded once Primary, Secondary and Tertiary treatment processes have been undertaken. Disinfection involves the application of chlorine, ozone or ultraviolet light to the treated wastewater (a combination can also be used). Chlorine disinfection is widely used due to its low cost, and its effectiveness at eliminating pathogens. The application of chlorine involves dosing the water following tertiary treatment with a chlorine concentration tailored to the wastewater characteristics. Chlorine disinfection works by oxidising cellular material and therefore kills all pathogenic microorganisms that may still be presented in the treated wastewater‡.

Ozone disinfection is increasingly being used due to its effectiveness at eliminating pathogens with minimal contact time and without the production of by-products foreign to natural water that chlorine produces [34]. Ozone disinfection works by exposing the wastewater to ozone in a contact chamber.

Ultraviolet (UV) disinfection utilises UV radiation to deactivate the cell of pathogenic microorganisms and can be particularly effective for protozoa (where chlorine is not so effective). UV disinfection is often combined with one of the other disinfection techniques mentioned.

4.2.4 Allotment Scale Wastewater Treatment Systems

There are many new and innovative products available in Australia for treating wastewater onsite on an allotment scale. These can include septic tanks and wastewater recycling units,

All on-site wastewater treatment systems in Victoria under 5000 litres per day capacity (even greywater treatment) will be classed as septic tanks in Victoria under the Environment Protection Act 1970. This means that they will require local authority approval. Traditionally septic systems treat sewage anaerobically to a primary treatment standard which then must be dispersed underground on the property.

More modern septic tank systems can treat a range of effluents including greywater, sewage and other wastewaters, using a range of different technologies. An example might be flat sheet membrane panels that are aerated, within an activated sludge treatment tank. Screening, degreasing, and de-gritting must occur prior to use of system usually with the use of a grease trap and a silage pit. Some modern units produce water to a secondary standard for irrigation.

Wastewater recycling units act on raw sewage or greywater to produce an alternative water source that is suitable for reuse. A wide range of technologies are available. An

‡ High chlorine levels can lead to corrosion issues in some cases.
example can be a system that separates gross solids and fine solids through continuous
deflection separation, then submerged aerated filters, fine sand or membrane filter, UV
disinfection and finally chlorine addition.

Sewage is transformed into water up to 10/10/10 or Class A standard. This water can
then be reused for toilet flushing, irrigation or other non-potable water uses. Many Green
Buildings are starting to implement water recycling units as a way of reducing
environmental impacts.

4.2.5 Natural treatment systems - Water Sensitive Urban Design (WSUD)

There is a trend in sustainable design to move from ‘grey’ infrastructure using concrete,
steel and plastic to build treatment systems to ‘green’ infrastructure which mostly uses
natural plants and microorganisms, constructed wetlands, bio-retention swales and other
engineered elements to treat water. The main benefit of WSUD for a site is that it can be
designed to be aesthetically pleasing, adding value to a site. Adding aquatic habitats to a
site also has enormous ecological benefits.

There are a range of treatment systems that can be applied to support WSUD
applications, usually to treat stormwater runoff or tertiary water treatment. These systems
encompass many of the principles already discussed. However, they are tailored to
directly address the treatment and management of site stormwater flows, and often
harness natural biological systems to achieve treatment objectives.

In alternative water resource projects that utilise stormwater, or for tertiary water
treatment, integration of WSUD principles would aid substantially in ensuring an optimal
design outcome. Guides of relevance include Water Sensitive Urban Design Guidelines
[18] and the Water Sensitive Urban Design Guidelines – Engineering Procedures –
Stormwater [22].
4.3 Water Storage

Once water is treated it usually needs to be stored prior to use.

Water tanks can be above ground or below ground. Below ground tanks can be conveniently placed under paving or in garden areas. Underground storage systems do not interfere with the visual amenity of the site and are favoured on sites where lot sizes may be too small to accommodate an above ground tanks.

The following are considerations to be addressed when planning a storage tank [67]:

- Most metal or plastic tanks must have a stand or base to carry the combined weight of the tank and water. If you are intending to use a pump to distribute the water, the rainwater tank can be at almost any level. If you wish to feed the water by gravity it is usually necessary to elevate the tank.

- When a rainwater tank is full, every kilolitre of water weighs 1000 kilograms (one tonne) so for safety it is important to construct a tank stand that is strong and stable. When a rainwater tank is empty it can be blown over by strong winds, so make sure your tank is adequately secured to the stand. Lightweight stands should be securely fixed to a heavy footing.

- To prevent external corrosion, the underside of metal rainwater tanks should be kept above the ground and sit on a self-draining base.

- Underground rainwater tanks must be sealed against the entry of surface run-off, groundwater and leaking sanitary drains that may contain pesticides, fertiliser and animal (or human) faecal material.
• Do not to place tanks inside the drip-line of a tree canopy. Root growth can damage the base of tanks.

• A rainwater tank should have an impervious cover to prevent the entry of dust, leaves, pollens, debris, vermin, birds, animals and insects. It is essential to seal access hatches with strong, close-fitting, childproof lids.

• The tank overflow should be connected to the appropriate sewer or stormwater connection.

4.3.1 Aquifer Storage and Recovery (ASR)

ASR is only briefly mentioned here as a potential storage option. Any of the treated alternative water resources described could apply ASR to enhance the viability of a project, even though ASR is most commonly partnered with stormwater collection.

ASR involves feeding treated water into an aquifer for storage and later recovery. The storage provided by the aquifer avoids problems associated with evaporation and may provide a more cost effective storage option versus surface storage [22].

Requirements of an ASR are summarised below [22]:

• The ASR should protect or improve groundwater quality where ASR is practiced
• The quality of recovered water should be fit for its intended use
• Aquifers and aquitards (fractured rock) should be protected from being damaged by depletion or excessive pressure (from over-injection)
• Problems such as clogging or excessive extraction of aquifer sediments should be avoided
• The system should ensure that reduced volumes of surface water downstream of the harvesting point are acceptable and consistent with a catchment management strategy

4.4 Understanding regulatory requirements

A complete study of the regulatory framework as it applies to alternative water sources in Victoria has been completed: Alternative Urban Water Supplies – Regulatory Review [27]. The document details all of the relevant legislation; the administrative bodies involved and suggested regulatory improvements.

To aid in interpreting the regulatory environmental, Table 26 in Appendix C - Further Resources & Tools, has been produced that can serve as a guide to assist an interested party to start to navigate the complex regulatory environment for the various alternative water resources.
4.5 Rainwater harvesting

4.5.1 Definition
Rainwater is defined in this guide as water collected directly from roof run-off. In general, rainwater provides a higher grade of water supply than other alternatives, and in many cases across Australia is used for drinking water [27].

4.5.2 Water quality issues
In urban areas where reticulated water is available it is usually recommended that rainwater is used for non-potable uses such as irrigation, toilet flushing and cooling towers (with appropriate treatments). In urban areas there is a higher risk of airborne pollutants being captured by rainwater tanks so greater care must be taken to ensure good water quality. Normally a first flush device will divert the first, most polluted portion of any rainfall event to stormwater, improving water quality in the tank. Rainwater can be filtered and disinfected with UV sterilisation to improve quality further. Care must also be taken to ensure that tanks are mosquito proofed.

It should be recognised that in many regional areas where reticulated water is less palatable, rainwater is preferred for drinking and reticulated water is used for non-potable uses. Table 12 outlines a generic risk assessment for rainwater harvesting in various applications.

Table 12: Inherent risk assessment of rainwater harvesting in various applications showing the findings of an expert panel reviewing the risks and potential applications of alternative water resources [21]. Risk management key: H = high, M = medium, L = low

<table>
<thead>
<tr>
<th>Use</th>
<th>Source: with no treatment</th>
<th>Source: with treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Kitchen</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Personal Washing</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Evaporative coolers</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Clothes washing</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Indoor cleaning</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Swimming pools</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Recreational activities</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Toilet flushing</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Surface watering of food crops to be eaten raw</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Surface watering</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Subsurface watering</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Washing cars and outdoor surfaces</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Ornamental water features</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Firefighting with hoses</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Firefighting with sprinklers</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Construction</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

4.5.3 Technology and cost considerations
Roof rainwater is the simplest and most cost effective alternative water source, and should always be the first consideration after efficiency in any water saving project. Rainwater is widely accepted and over the last 10 years mass production has reduced the cost and improved the quality of rainwater systems.
Use of rainwater to either fully or partially supply residential water needs has been extensively studied. The study ‘Analysis of the Performance of Rainwater Tanks in Australian Capital Cities’ [36], suggests that a significant portion of household water requirements could be supplied by water tanks (13% to 67% of water requirements for a 200 square metre rooftop, and between 1 and 10 kilolitres of tank storage). In non-residential buildings rainwater can supply much of the water required for non-potable uses, especially in low rise or single story buildings.

A challenging aspect of this water resource is variability of supply versus other alternative water resources. Reticulated water top-up will usually be required to ensure reliability.

Reliability can be measured as the percentage of water that can be supplied from a water tank rather than from external tank top-up. Generally, the larger the water tank in proportion to the water demand the more reliable it will be.

Rainwater capture is proportional to the following variables:

- Size of roof catchment (only areas actually draining to the tank)
- Size of water tank, which determines the amount of water lost to overflow
- Water demand and usage patterns, which determines how much free capacity is available for each rainfall event, and how much rainwater can actually be used
- Any other losses such as runoff coefficient, evaporation and first flush devices

Usually for larger projects, specialist advice is required to develop a more refined estimate, using water balance modelling in a spreadsheet or proprietary web or software tool. However, whilst it is less accurate, it is possible to develop a simplified estimate of water collection potential by using annual or monthly rainfall data and expected size of the catchment area as shown below. This method may be a simple means of estimating the suitability of this source of water before design resources are made available.

A key challenge with rainwater collection is the seasonality of rainfall, which can mean an oversupply of water in winter months and a shortage in summer months. For this reason the calculation described below is best performed for each month or even for each day over a given year. In this way it possible to consider the variability of supply and how this might impact the potential application. From a pure water savings perspective, rainwater tanks in the urban context need only be used as a supplementary source of water. The presence of a predictable, year round piped water supply means that large on-site storage is not needed to provide supply security. In an urban water saving context a smaller tank delivering 60-80% reliability is delivering a 60-80% reduction in mains water for its intended uses.

That said, another aspect to consider is variations in rainfall patterns, and how this will affect the purpose of installing a water tank. For example, if a rainwater system is being designed to irrigate a garden during drought and water restrictions, then worst case
rainfall scenarios should be modelled and a large enough storage selected to ensure that the system to fulfils its purpose.

An example of how to calculate potential water supply from a rainwater tank is provided below.

**Equation 1: Calculating Potential water supply from rainfall.**

(Source: Ark Resources 2004, *Capture and on-site use of rainwater*, developed for the EPA, Victorian State Government and Manningham Council)

For each month (or day) of the year using a spreadsheet calculate the following steps. Rainfall data for most locations is readily available from the Australian Bureau of Meteorology.

**Step 1 - Calculate demand**

The water demand is calculated where:

- Irrigation water (litres) = Irrigation Area (m²) x Daily Irrigation (mm/m²) x Days in month
- Toilet Water Use (litres) = Number of People x Daily Toilet Demand ((l/person/day) x Days in month

Where: Daily Toilet Demand ((l/person/day) = 1 x full flush volumes + 4 x half flush volumes

Other non-potable water demands (such as cooling towers or fire services) can also be calculated for each time step. Irrigation demand tables for your area can be obtained from the Bureau of Meteorology.

**Step 2 - Runoff**

The amount of water that can be collected can be related to the size of the collection area and the local rainfall patterns. A runoff coefficient is applied to account for the surface type and the amount of water which ‘soaks in, spills, or is otherwise lost in collection.

Collection area is the roof area connected through down-pipes to the water tank.

\[
\text{Runoff (litres)} = \text{Runoff Coefficient} \times \text{Rainfall (mm)} \times \text{Collection Area (m²)}
\]

**Step 3 – Transitional Storage Level**

Calculate the Transitional Storage Level (litres). This is the amount of water that fills the tank. The initial storage area is the amount of water contained in the tank at the start of the period.

\[
\text{Transitional Storage Level (litres)} = \text{Initial Storage Level (litres)} + \text{Runoff (litres)}
\]

**Step 4 – Stormwater Overflow**

Calculate the amount of stormwater overflow. Does the Transitional Storage Level exceed the Tank Storage Capacity?
YES?

Stormwater Overflow (litres) = Transitional Storage Level (litres) – Tank Capacity (litres)

New Storage Level (litres) = Tank Capacity (litres)

NO?

Stormwater Overflow = 0

New Storage Level (litres) = Transitional Storage Level (litres)

STEP 5 – Final Tank Level and Top-up

Calculate Final Storage Level and Mains Water Top-up.

Does Water Demand for the present period exceed New Water Storage Level?

YES?

Rainwater Supplied (litres) = New Storage Level (litres)

Mains Water Top-up (litres) = Water Demand (litres) – New Storage Level (litres)

Final Storage Level (litres) = 0

NO?

Rainwater Supplied (litres) = Water Demand (litres)

Mains Water Top-up = 0

Final Storage Level (litres) = New Storage Level (litres) – Water Demand (litres)

The Final Storage Level should be carried into the next period and entered as the initial storage level and the process repeated.

STEP 6 – Calculate Water Savings

Reduced annual stormwater runoff for the building is:

\[1 - \frac{\text{Stormwater Overflow}}{\text{Runoff}}\] \times 100

Reduced annual mains water demand is:

Total Rainwater Supplied (litres)

The tank reliability is:

\[1 - \frac{\text{Mains Water Top-up}}{\text{Water Demand}}\] \times 100

A worked example on how to calculate potential rainwater supply follows. A Rainwater tank is to be installed for toilet flushing and irrigation. The water tank will also be used to
reduce stormwater runoff, thereby reducing nitrogen runoff from the site. The following example uses the captured rainwater for both toilet flushing and irrigation.

Table 13: The building water uses for this example are as follows

<table>
<thead>
<tr>
<th>Irrigation Area</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people</td>
<td>25</td>
</tr>
<tr>
<td>Toilet Demand (/person/day)</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 14: Worked Example of water demand is calculated as follows

<table>
<thead>
<tr>
<th>Days in month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>31</td>
<td>28</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Daily Irrigation (mm/m²)</td>
<td>2.8</td>
<td>2.5</td>
<td>1.6</td>
<td>0.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
<td>1.5</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Irrigation Water Use (l)</td>
<td>17360</td>
<td>14000</td>
<td>9920</td>
<td>2400</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3720</td>
<td>9000</td>
<td>14260</td>
</tr>
<tr>
<td>Toilet Water Use (l)</td>
<td>13950</td>
<td>12600</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
</tr>
<tr>
<td>Other (enter monthly litres)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Demand (l)</td>
<td>31310</td>
<td>26600</td>
<td>23870</td>
<td>15900</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>17670</td>
<td>22500</td>
</tr>
</tbody>
</table>

Table 15: Building Details for this example

| Collection Area (m²) | 800 |
| Runoff Co-Efficient | 0.95 |
| Storage Capacity (l) | 25000 |

Table 16: Worked Example of water tank balance for Toilet Flushing and Irrigation

<table>
<thead>
<tr>
<th>Monthly Rainfall (mm)</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Demand (l)</td>
<td>31310</td>
<td>26600</td>
<td>23870</td>
<td>15900</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>17670</td>
<td>22500</td>
</tr>
<tr>
<td>Runoff (l)</td>
<td>36556</td>
<td>35872</td>
<td>38684</td>
<td>44308</td>
<td>43168</td>
<td>37848</td>
<td>36404</td>
<td>38228</td>
<td>44764</td>
<td>51224</td>
<td>45296</td>
<td>44840</td>
</tr>
<tr>
<td>Initial Tank Storage Level (l)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1130</td>
<td>9100</td>
<td>11050</td>
<td>11500</td>
<td>11050</td>
<td>11050</td>
<td>11500</td>
<td>7330</td>
<td>25000</td>
</tr>
<tr>
<td>Transitional Storage Level (l)</td>
<td>36556</td>
<td>35872</td>
<td>38684</td>
<td>45438</td>
<td>52268</td>
<td>48896</td>
<td>47904</td>
<td>49278</td>
<td>55814</td>
<td>62724</td>
<td>52626</td>
<td>47340</td>
</tr>
<tr>
<td>Stormwater Overflow (l)</td>
<td>11556</td>
<td>10872</td>
<td>13684</td>
<td>20438</td>
<td>27268</td>
<td>23898</td>
<td>22904</td>
<td>24278</td>
<td>30814</td>
<td>37724</td>
<td>27626</td>
<td>22340</td>
</tr>
<tr>
<td>New Storage Level (l)</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
<td>25000</td>
</tr>
<tr>
<td>Rainwater Supplied (l)</td>
<td>25000</td>
<td>25000</td>
<td>23870</td>
<td>15900</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>13950</td>
<td>13500</td>
<td>17670</td>
<td>22500</td>
</tr>
<tr>
<td>Mains Water Top-up (l)</td>
<td>6310</td>
<td>1600</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3210</td>
</tr>
<tr>
<td>Final Storage Level (l)</td>
<td>0</td>
<td>1130</td>
<td>9100</td>
<td>11050</td>
<td>11500</td>
<td>11050</td>
<td>11500</td>
<td>11050</td>
<td>11500</td>
<td>7330</td>
<td>25000</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 17: Results of the water tank balance calculations

<table>
<thead>
<tr>
<th>Totals</th>
<th>Monthly Rainfall (mm)</th>
<th>No Tank</th>
<th>Water Demand (l)</th>
<th>234910</th>
<th>Runoff (l)</th>
<th>497192</th>
<th>Stormwater Overflow (l)</th>
<th>273402</th>
<th>Rainwater Supplied (l)</th>
<th>223790</th>
<th>Mains Water Top-up (l)</th>
<th>11120</th>
</tr>
</thead>
</table>

Therefore water savings are as follows:

- Non-potable Water Use Reduction: 95%
- Tank Reliability: 95%
- Stormwater runoff reduction: 45%
4.5.4 Environmental considerations

Environmental considerations for rainwater systems include [37]:

- A reduction in water discharges to the environment (e.g. wetlands, streams, rivers).
- The potential to directly substitute for potable water supply.
- Impacts on health of the environment (e.g. river health).
- Medium level of energy use and associated greenhouse gas emissions.
- Increased materials use.
- Likely increase in chemical use.

4.5.5 Social considerations

Social considerations for rainwater systems include [37]:

- A potential to increase community awareness of water in the urban environment
- Water tanks are iconic to water conservation awareness
- Water tanks greater than 4.5 kL in size could be regarded as taking away from the appearance of a building.
- High level of acceptable within a community.
- Accessible technology and easy to retrofit.
- Geographically equitable – suitable for all locations around Australia.
- Low to medium levels of maintenance.

Flow on benefits for the local community include improved amenity in drought, improved local environmental quality, reduced local flooding risk and the reduced need for public infrastructure upgrades.
4.6 Stormwater

4.6.1 Definition

Stormwater is defined in this guide as rainfall run-off from urban areas [1]. In many cases treatment is required to make stormwater fit for purpose. Rainwater is differentiated from stormwater in that rainwater is collected directly from roof runoff, whereas stormwater is collected from surface run-off.

Figure 27: Water Sensitive Urban Design water feature in the Melbourne Docklands (image source: www.wsud.org). Three free surface wetlands are situated in Docklands Park to treat stormwater runoff from the Docklands Grand Plaza, Harbour Esplanade, NAB building and forecourt. Treated water is stored in adjacent underground storages. This water is used for Docklands Park irrigation.

4.6.2 Water quality issues

The collection of stormwater for use as an alternative water resource can be undertaken using a variety of methods. Water Sensitive Urban Design Engineering (WSUD) Procedures [22], describes in detail the design principles and methodologies, although the focus is primarily geared to stormwater management, treatment and disposal to the environment. The principles outlined, however, could also be applied to an alternative water resource design. WSUD features will help to filter and purify water to a quality where it is readily reused for a number of less sensitive non-potable purposes such as irrigation. Table 18 outlines a generic risk assessment for stormwater resources in various applications.
Table 18: Inherent risk assessment of stormwater resources in various applications showing the findings of an expert panel reviewing the risks and potential applications of alternative water resources [21]. Risk management key: H = high, M = medium, L = low

<table>
<thead>
<tr>
<th>Use</th>
<th>Source: no treatment beyond pondage</th>
<th>Source: with treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Kitchen</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Personal Washing</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Evaporative coolers</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Clothes washing</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Indoor cleaning</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Swimming pools</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Recreational activities</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Toilet flushing</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Drinking</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Kitchen</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Personal Washing</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Evaporative coolers</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Clothes washing</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Indoor cleaning</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Swimming pools</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Recreational activities</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Toilet flushing</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Surface watering of food crops to be eaten raw</td>
<td>H (M)</td>
<td>M</td>
</tr>
<tr>
<td>Surface watering</td>
<td>H (M)</td>
<td>M</td>
</tr>
<tr>
<td>Subsurface watering</td>
<td>H (M)</td>
<td>M</td>
</tr>
<tr>
<td>Washing cars and outdoor surfaces</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Ornamental water features</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Firefighting with hoses</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Firefighting with sprinklers</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Construction</td>
<td>M</td>
<td>L</td>
</tr>
</tbody>
</table>

4.6.3 Technology and cost considerations

Mechanical treatment systems can be used to treat stormwater to a quality where it may be used for non-potable purposes such as irrigation, toilet flushing and commercial or industrial uses. Stormwater reuse systems need to ensure that plumbing issues are addressed to ensure that no cross contamination of the reticulated or rainwater supply occurs. In particular back flow prevention devices may need to be installed at the boundary of the property. A higher level of maintenance and monitoring of the system may be required due to the lower quality of the water that is being used.

Stormwater harvesting is widely accepted and can be cost effective, especially where the catchment is moderately well protected from pollutants, or where a WSUD strategy is being implemented on site. Stormwater can be stored in surface ponds (basins) or dams or in large underground detention tanks. Many sites are required to provide detention tanks or basins anyway to reduce peak flows from the site, and water harvesting from these detention basins is gaining acceptance. Large underground modular water tanks (greater than 6,000 litres) are being used in many commercial, residential and public buildings and can be designed to include a filtration unit and tank modules wrapped in geotextile fabric, with a polypropylene plastic liner.

Stormwater supply is dependent on a number of characteristics, including local climate, catchment area, land type and topology. To account for these characteristics, a number of existing modelling tools, including MUSIC (refer to www.toolkit.net.au) are available to assist in the calculation of potential stormwater supply.

4.6.4 Environmental considerations

In urban sites, care must be taken to ensure gross pollutants (litter), hydrocarbons (runoff from roads and car-parks, and sediments are removed from stormwater. The stormwater
can be then used for irrigation or treated further for more sensitive uses such as toilet flushing.

Environmental benefits of stormwater systems include [37]:

- The potential to improve waterway health
- Potable reuse will decrease reliance on existing potable supply.
- Impacts on health of the environment (e.g., river health).
- Medium level of energy use and associated greenhouse gas emissions.
- Increased materials use.
- Likely increase in chemical use.

### 4.6.5 Social considerations

Stormwater harvesting systems may have the following social impacts [37]:

- Waterways and related stormwater basins are considered a valuable community asset. Increased harvesting of stormwater has the potential to denigrate the public value of retarding basins which are currently highly valued public open space regions when not in flood.
- Has the potential to significantly improve the water assets of the community in the urban environment.
- High level of acceptable within a community.
- Accessible technology and easy to retrofit.
- Geographically equitable – suitable for all locations around Australia.
- Low to medium levels of maintenance.
- Flow on benefits for the local community include improved amenity in drought, improved local environmental quality, reduced local flooding risk and the reduced need for public infrastructure upgrades.
4.7 Wastewater

4.7.1 Definition
Wastewater is an alternative water resource that is derived from a waste flow and can be used either in its untreated form (reused) or treated.

Treated wastewater is defined in this review as water that has been derived from a wastewater stream which has been treated to a standard that is appropriate for its intended use.

In this guide, recycled water is considered a subset of treated wastewater and is often used to refer to sewage that has been treated to a ‘Class A’ or better standard.

4.7.2 Water quality issues
Applications of treated wastewater vary enormously from drinking water to basic agricultural applications. Application is governed primarily by the treatment system employed, which should be designed to deliver water quality that is fit-for-purpose.

Depending on the level of treatment, recycled wastewater may be used for:

- Garden watering, car washing, toilet flushing and clothes washing;
- Irrigation for urban recreational and open space, and agriculture and horticulture;
- Fire protection and fire fighting systems;
- Industrial uses, including cooling water; and
- Subsurface irrigation of landscapes.

Table 19 outlines a generic risk assessment for recycled wastewater in various applications.
Table 19: Inherent risk assessment of recycled wastewater resources in various applications showing the findings of an expert panel reviewing the risks and potential applications of alternative water resources [21]. Risk management key: H= high, M = medium, L = low

<table>
<thead>
<tr>
<th>Use</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td>H</td>
</tr>
<tr>
<td>Kitchen</td>
<td>H</td>
</tr>
<tr>
<td>Personal Washing</td>
<td>H</td>
</tr>
<tr>
<td>Evaporative coolers</td>
<td>M</td>
</tr>
<tr>
<td>Clothes washing</td>
<td>L</td>
</tr>
<tr>
<td>Indoor cleaning</td>
<td>L</td>
</tr>
<tr>
<td>Swimming pools</td>
<td>M</td>
</tr>
<tr>
<td>Recreational activities</td>
<td>M (L)</td>
</tr>
<tr>
<td>Toilet flushing</td>
<td>L</td>
</tr>
<tr>
<td>Surface watering of food crops to be eaten raw</td>
<td>M</td>
</tr>
<tr>
<td>Surface watering</td>
<td>H</td>
</tr>
<tr>
<td>Subsurface watering</td>
<td>M</td>
</tr>
<tr>
<td>Washing cars and outdoor surfaces</td>
<td>M (L)</td>
</tr>
<tr>
<td>Ornamental water features</td>
<td>M (L)</td>
</tr>
<tr>
<td>Firefighting with hoses</td>
<td>L</td>
</tr>
<tr>
<td>Firefighting with sprinklers</td>
<td>L</td>
</tr>
<tr>
<td>Construction</td>
<td>L</td>
</tr>
</tbody>
</table>

Source: Recycled water

4.7.3 Technology and cost considerations

Some of the primary advantages of treated wastewater can be: its availability; its consistent flow throughout the year; consistent qualities due to the use of new technologies; and security of supply, especially in times of restrictions.

A major source of recycled water (a form of treated wastewater) is from centralised wastewater treatment plants. Radcliffe [38] states that 10% of wastewater from Australian sewage treatment plants is currently being recycled. In the past, use has taken place in agricultural areas with only a small fraction being reused in major cities. However, in recent years practices in cities have changed significantly. Using Melbourne as an example, since Radcliffe’s [38] report, recycling rates have increased significantly (refer Table 20).

Table 20: Recycling rates for the consolidated Melbourne region [39].

<table>
<thead>
<tr>
<th>YEAR</th>
<th>% WATER RECYCLED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999-2000</td>
<td>2.0</td>
</tr>
<tr>
<td>2000-01</td>
<td>2.0</td>
</tr>
<tr>
<td>2001-02</td>
<td>5.7</td>
</tr>
<tr>
<td>2002-03</td>
<td>10.9</td>
</tr>
<tr>
<td>2003-04</td>
<td>11.4</td>
</tr>
<tr>
<td>2004-05</td>
<td>11.6</td>
</tr>
</tbody>
</table>
The benefits of increasing wastewater recycling have been broadly recognised by governments. In Victoria, the government has a stated target of recycling 20% of Melbourne’s wastewater by 2010, which was achieved by Melbourne in 2007 [40].

In Melbourne, recycled wastewater from the Eastern Treatment Plant (ETP) and the Western Treatment Plant (WTP) is available for use by industry [41]. In most applications, water is supplied to a Class A treatment standard making it suitable for most non-potable uses.

The supply of recycled water from local water treatment plants represents another alternative water source. This recycled water may be provided in combination of recycled water from ETP/WTP. Further consultation with your local water retailer about these opportunities is recommended.

Risks associated with the use of treated sewage are minimised via EPA regulation and control measures taken by water utilities. These control measures include source control measures for trade wastes, advanced treatment technologies and recycled water quality monitoring programs and risk management plans completed by end users.

In most cases, water users do not have access to piped recycled water so they must transport it from the treatment plant to the application by truck. This not only increases the cost of the water, but also leads to increased environmental impacts from transportation.

Decentralised wastewater recycling schemes include single and multi-site based systems and can include sewer mining, industrial wastewater recycling schemes, and single- or multi-site greywater systems. On site wastewater recycling plants are becoming more common in Australia and can be bought off the shelf or tailored. Innovations arising in the development of advanced membrane and other treatment technologies may provide low cost and effective ways of safely reusing blackwater on a multi-site basis. There are different regulatory requirements for both single and multi-site systems. Multi-site schemes are likely to require involvement of local and state authorities. Consultation with the EPA and local authorities is recommended for both on site and multi-site wastewater recycling systems.

### 4.7.4 Environmental considerations

Wastewater systems may lead to the following environmental implications [37]:

- Increased concentration of sewage (e.g. nutrients, salt), leading to land and waterway contamination.
- Greenhouse gas emissions associated with energy consumption for pumping and treatment systems.
- Additional environmental or urban flows available resulting from a reduced demand on water from catchments.
• Reduced nitrogen loading in waterways, including bays and oceans.
• Increased materials use in infrastructure and replacement parts.
• Increase in chemical use.

4.7.5 Social considerations

Wastewater systems may have the following social implications [37]:

• Treatment plant may generate noise and odour problems
• Community concerns may be reflected in permit difficulties
• Reduced water restrictions
• Promotion of gardening activities to benefit the urban environment
• Potential to be unpopular with community.
• Potential disruption to existing built environment if not installed during the construction phase
• Industry education to ensure appropriate use
• Potential health risks for proposed use
• Wastewater recycling is visible to the community and raises community awareness about water conservation.
• Geographically equitable – suitable for all locations around Australia.
• High levels of on-going maintenance.
• Flow on benefits for the local community include improved security of supply and the reduced need for public infrastructure upgrades.
4.8 **Greywater**

4.8.1 **Definition**

Greywater is defined in this review as water which has not been contaminated by toilet discharge and includes water from showers, condensate, washing machines and basins. [1].

**Figure 28:** Public Housing Greywater Treatment System, using a sub-surface wetland. Fitzroy, Melbourne (image source: www.wsud.org)

4.8.2 **Water quality issues**

Untreated greywater probably one of the most common residential reuse sources. In non-residential applications, reuse could extend to a variety of waste flows in a manufacturing process, to large scale commercial building greywater containment and reuse, or to other applications.

Subsequent to the release of the EPA guidelines with respect to recycled water, the EPA has released guidelines with respect to dual pipe recycling schemes [28]. This document discusses the use of Class A water in a domestic and industrial setting, introducing considerations for use according to application. This latter set of guidelines [28] is now regarded as the more appropriate guideline for Class A water quality (refer Table 6). Table 21 outlines a generic risk assessment for greywater resources in various applications.
Table 21: Inherent risk assessment of greywater resources in various applications showing the findings of an expert panel reviewing the risks and potential applications of alternative water resources [21]. Risk management key: H= high, M = medium, L = low

<table>
<thead>
<tr>
<th>Use</th>
<th>Source: diversion only</th>
<th>Source: 24 hr storage</th>
<th>Source: treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Kitchen</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Personal Washing</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Evaporative coolers</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Clothes washing</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Indoor cleaning</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Swimming pool</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Recreational activities</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Toilet flushing</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Surface watering of food crops to be eaten raw</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Surface watering</td>
<td>H</td>
<td>H(L)</td>
<td>M</td>
</tr>
<tr>
<td>Subsurface watering</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Washing cars and outdoor surfaces</td>
<td>M</td>
<td>H</td>
<td>M(L)</td>
</tr>
<tr>
<td>Ornamental water features</td>
<td>M(L)</td>
<td>M</td>
<td>M(L)</td>
</tr>
<tr>
<td>Firefighting with hoses</td>
<td>M(L)</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Firefighting with sprinklers</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Construction</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
</tbody>
</table>

4.8.3 Technology and cost considerations

Greywater can sometimes be simply diverted and reused, or treated on site to a high standard. In the most simple systems the greywater is diverted and used untreated in sub-surface irrigation.

Greywater can be treated by using green infrastructure such as sub surface wetlands. Sub surface wetlands are water bodies covered in gravel so that no surface water is visible. The water is treated by plants and microorganisms in the treatment system.

Greywater can also be treated with mechanical systems. There are an increasing number of commercial systems that offer a combination of features, which may include diversion, filters, treatment, storage and pumping. A system, which comprises a diverter valve plus small filter, storage cell, pump and automatic dump after 24 hours, is commonly used for garden irrigation where greywater cannot reach the garden under gravity. Another product comprises diversion, storage tank, pump, filter, float switch and auto electric controller as well as daily automatic release to sewer or garden for excess water. Systems with built in pumps have the advantage of not needing to operate under gravity.

Significant innovation has occurred within this sector in recent times with several systems now available that treat greywater to the highest possible standards for recycled water (Class A or Tertiary treatment level with disinfection). These systems generally continuously monitor the water quality and system performance and require minimal maintenance by the building owner/occupier – hence reducing risks.

These systems are often designed to fit into small spaces making them ideal for use in buildings. These types of systems are likely to be more suitable for commercial / public / industrial buildings [60]. For larger developments a system can be tailored to the water demands and greywater sources available on-site.
4.8.4 Environmental considerations

Environmental considerations for greywater systems include [37]:

- Increased concentration of sewage (e.g. nutrients, salt), leading to land and waterway contamination.
- Greenhouse gas emissions associated with energy consumption for pumping and treatment systems.
- Additional environmental or urban flows available resulting from a reduced demand on water from catchments.
- Increased materials use in infrastructure and replacement parts.
- Increase in chemical use.

4.8.5 Social considerations

Social considerations for greywater systems include [37]:

- Treatment plant may generate noise and odour problems
- Community concerns may be reflected in permit difficulties
- Reduced water restrictions
- Promotion of gardening activities to benefit the urban environment
- Potential to be unpopular with community.
- Potential health risks for proposed use
- Potential disruption to existing built environment if not installed during the construction phase
- Industry education to ensure appropriate use
- Wastewater recycling is visible to the community and raises community awareness about water conservation.
- Geographically equitable – suitable for all locations around Australia.
- High levels of on-going maintenance.
- Flow on benefits for the local community include improved security of supply and the reduced need for public infrastructure upgrades.
4.9 Untreated wastewater

4.9.1 Definition

Untreated wastewater reuse is defined as using an untreated wastewater stream to undertake a secondary activity. Untreated wastewater can include untreated discharge from an industrial process, water from domestic sinks, basins, and kitchens (greywater), or sewage water (blackwater).

4.9.2 Water quality issues

Care should always be taken in reusing untreated wastewater to ensure that the water is of sufficient quality for the required end use. Common hazards may include [42, 43]:

- Pathogenic organisms
- Nutrients (nitrogen and phosphorus)
- Biodegradable organics (composed principally of proteins, carbohydrates and fats)
- Refractory organics which tend to resist conventional methods of wastewater treatment (for example, phenols and agricultural pesticides)
- Dissolved inorganics (for example, calcium and sodium)
- Metals (for example, arsenic, barium, cadmium, chromium, lead, mercury and silver)
- Suspended solids
- Organic and inorganic compounds with toxicity
- Non-pathogenic organisms that may cause odour, or corrosion and scaling of equipment

4.9.3 Technology and cost considerations

Economically, the reuse of wastewater will often be most effective because treatment infrastructure is not required. Water such as single pass though process water (cooling water, or fire testing water for example) may be suitable for immediate reuse. Applications for water reuse are driven by the quality of the waste stream being tapped, and the needs of the application. A spectrum of possible applications could be envisaged, many of which would be described by Table 3.

4.9.4 Environmental considerations

Environmental considerations for untreated wastewater systems include [37]:

- Increased concentration of sewage (e.g. nutrients, salt), leading to land and waterway contamination.
- Low greenhouse gas emissions.
• Additional environmental or urban flows available resulting from a reduced demand on water from catchments.

• Potential soil and environmental contamination due to direct use of untreated contaminants.

4.9.5 Social considerations

• Potential health risks both onsite and downstream

• May generate odour problems

• Easy and low cost adoption by community

• Community education to ensure appropriate use

4.10 The Alternative Water Resource Preliminary Design Assessment Tool

The Alternative Water Resource Preliminary Design Assessment Tool (AWR PDA Tool) has been developed on behalf of the Smart Water Fund to assist project teams and decision-makers to quantify the potential benefits of on-site alternative water resource technologies in the early design process. The AWR PDA Tool allows for a streamlined Triple Bottom Line (TBL) assessment of alternative water resource options, based on economic, environmental, and social implications. The scope of the tool is limited to the assessment of on-site alternative water resources, such as on-site wastewater recycling systems, greywater systems and rainwater collection systems. Preliminary assessments of alternative water resources which utilise reticulated water (e.g. third pipe schemes, sewer mining or stormwater harvesting) are typically performed by water authorities. It is recommended that project teams and decision makers who are investigating such schemes contact their local water authority for assistance in undertaking a preliminary assessment.

The streamlined assessment undertaken in the AWR PDA Tool provides a mix of quantitative and qualitative data points to assess design performance. The comparison of up to three alternative water resource technology designs facilitates for a preliminary selection of the optimal design across the TBL.

The AWR PDA Tool is a Microsoft Excel workbook that incorporates Visual Basic macros to make navigation and data-entry clear. The basis for the economic, environmental and social impact assessment used in the AWR PDA tool are provided in Sections 5.2 through to 5.4. The AWR PDA Tool provides directional guidance only and users are advised to seek independent verification of results. The AWR PDA tool is designed to work as a simple TBL assessment in its current form, however could be readily modified and tailored to suit the needs of a particular project or business model, including the addition of other social and environmental assessment criteria which may be stipulated by government agencies (e.g. waterway improvements, nitrate loading etc.)
Alternative Water Resource
Preliminary Design Assessment Tool
Version: alpha-1

This excel based tool has been developed to aid in the assessment and selection of Alternative Water Resource (AWR) system designs. The tool is designed to allow those considering AWR systems to compare designs against economic, environmental and social criteria. The tool is designed to be used at an early stage of the design process when designers are considering various AWR options, but have yet to undertake detailed system design. The tool is designed to provide directional guidance only, and should not substitute for detailed design assessment.

Assessment process:
1. Complete an Alternative Water Resource - Preliminary Assessment worksheet for each design being considered (up to three designs can be compared at once). Enter data only in those cells marked yellow (other cells are protected).
2. Use comments and item numbers to help understand the calculations. Scrolling over a commented cell (denoted by a red triangle in the upper right corner) will reveal a comment.
3. Compare the designs using the Alternative Water Resource - Design Comparison worksheet. The Design Comparison worksheet aggregates key aspects of the Preliminary Assessment worksheets completed for each design option, and provides a printable report.
4. Navigate through the assessment using the navigation buttons provided at the top of each worksheet.
5. Use the clear button to clear the sheet and reset the defaults.

Note to advanced excel users:
The workbook and each worksheet has been protected with the password "smartwater". Advanced excel users may wish to modify the tool to suit specific purposes and can do so by unlocking the workbook and worksheets via 'Protection' menu under the 'Tools' menu.
5 ESTABLISHING THE BUSINESS CASE

The following section of the guide will provide an overview of some relevant design assessment methods that can be applied to alternative water resource technologies. This section then integrates key aspects into a simple decision support tool that designers can use to assess alternative water resource technology options. In addition to these guidelines, support and consultation may be required from authorities and stakeholders, including planning, water, environmental and council authorities. It is recommended that in all cases, that the relevant authorities and stakeholders be involved as part of establishing a business case.

5.1 The Triple Bottom Line (TBL)

Having reviewed the many options available for alternative water resource technologies it is necessary to develop some criteria against which the design options can be assessed. It is usual at this stage for certain alternative water resource technology options to be obvious to an organisation to employ in its mains water reduction programme. Usually limitations prevent designers from implementing all options, so decisions need to be made as to which are best and which options should be pursued. Often these decisions are made in an ad-hoc way based on the experience of the designers or project team members involved. However, to ensure that all the competing criteria are properly considered, a formal review should be completed.

The most effective way of considering the suitability of an alternative water resource technology design is to apply a ‘Triple Bottom Line’ assessment [44]. A TBL assessment attempts to consider the Economic, Environmental and Social impacts of a proposed design, thereby attempting to enhance the sustainability outcomes. A traditional design assessment may only focus on economic and technical feasibility aspects of a design, whereas a TBL assessment addresses broader social and environmental implications.

In practice a TBL assessment is undertaken in the form of a Multi Criteria Analysis (MCA) which will rank options as more or less favourable. An MCA analysis will examine and apply weightings to the various, economic, technical, social and environmental issues in a given project.

5.1.1 Multi Criteria Analysis (MCA)

A simple assessment can be achieved by using Multi Criteria Analysis (MCA) to assess the performance of each design. A simple MCA can be undertaken by giving each technical criterion a weighting equal to its level of relative importance. Each design is then given a rating against each criterion that reflects the level to which the design conforms to the criterion. A score for each criterion is then determined for the design based on the weighting multiplied by the conformance rating. A designs’ total score then becomes the total of each criterion score.

An example of a simple MCA is shown in Figure 30. In this example three design options, A, B and C are assessed against three technical criteria. In this case the process first
involved determining a weighting for each of the criteria, as shown in the Weighting column. Then each design was assessed for conformance to the criteria, and given a rating. Finally scores were calculated for each criterion and design option and total scores developed.

**Figure 30: Multi Criteria Analysis example**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting</th>
<th>Proven application of technology</th>
<th>Operability of technology</th>
<th>Plant start up/shut down</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 to 5</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>5=important</td>
<td>1=unimportant</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Conformance to criteria, 1 to 5</td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5=conforms, 1=does not conform</td>
<td></td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Weighting x Rating</td>
<td>4</td>
<td>16</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>14</td>
<td>26</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

MCA as shown here can be very useful when working across multiple and competing criteria. It does, however, have some weaknesses that need to be understood, such as the heavy reliance on the abilities of the assessor developing the weightings and conformance ratings. Transparency can also be a problem, especially when total scores are presented without sufficient supporting details. For these reasons, MCA is often conducted by a panel of experts, who discuss and seek consensus upon each aspect. When results are presented, there is usually some discussion regarding the drivers of the scores achieved.

Finally, it is also possible to use an MCA approach across the entire TBL assessment, and indeed this has been done in projects before. A good MCA will incorporate elements from the Economic, Environmental, and Social Assessment tools outlined below.

One challenge of MCA is that social and environmental aspects can be difficult to quantify and weight. Weighting of social and environmental aspects should be done in an open and transparent way, with consultation and input from all relevant stakeholders.

### 5.2 Economic assessment

Economic assessment of alternative water resource technology designs is typically related to basic questions of construction cost versus savings generated. Often costs considered are limited to those experienced by the firm installing the system, however in some cases (usually government projects) costs incurred and benefits generated may be considered more widely.

Underlying the economic assessment of a project is the technical feasibility of the design. Although seldom considered an economic issue, technical feasibility underpins the costing of a project, so arguably contributes most significantly to the economic bottom line in a TBL assessment.
In this guide both technical and traditional economic assessments have been considered components of the economic bottom line and are addressed in the following sections.

### 5.2.1 Technical Assessment

One of the most important alternative water resource technology design criterion is: will it work? Technical assessment is a method for trying to understand the risks associated with the construction and function of the proposed design. For most smaller scale alternative water systems the manufacturer and the installers will have done much of the product technical assessment work already. If this is the case it is important to discuss and understand warranties, contractual risks and contingencies for maintaining the system.

For larger engineered systems a more detailed feasibility study should be undertaken. This can be done in-house if the organisation has sufficient technical capability, otherwise external consultants should be utilised.

Although outside experts usually cost money, investing some resources in ensuring a design will function as planned will usually prove worthwhile. Many engineering firms specialise in developing water reduction solutions. A list of contacts for the Melbourne area is provided in Appendix A - Water Consultants operating in Victoria.

### 5.2.2 Technical Assessment - example

One method of undertaking technical assessment is to break the problem down into distinct features of the design that can be assessed while it is on the drawing board.

Such an assessment was undertaken when Sydney Water reviewed design options associated with a large scale desalination plant under consideration.

**Table 22: Selection criteria used by Sydney Water when reviewing desalination plant design options [45].**

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational/Process</td>
<td></td>
</tr>
<tr>
<td>Proven application of technology</td>
<td>Proof that a proposed option can operate at the capacity required. Includes power generation technology</td>
</tr>
<tr>
<td>Ability of technology to meet current reclaimed water standards</td>
<td>Ability of technology to produce reclaimed water that meet EPA Victoria Use of Reclaimed Water Guidelines</td>
</tr>
<tr>
<td>Operability of technology</td>
<td>Ease at which the plant can be run and operated, including training of plant staff, shift work issues, automation of processes</td>
</tr>
<tr>
<td>Reliability and maintainability of technology</td>
<td>Reliability of plant technology based on previous experience, and the difficulty of maintenance of the technology</td>
</tr>
<tr>
<td>Plant start-up/shut down</td>
<td>Plant start-up / shut down characteristics. Includes time to start up/shut down, ease at which plant can be started up/shut down, and length of down time</td>
</tr>
<tr>
<td>Ability to put plant in standby mode</td>
<td>Ability of a plant to be placed in standby mode</td>
</tr>
<tr>
<td>Sensitivity to intake wastewater quality</td>
<td>Ability of a plant to handle differing qualities of intake wastewater</td>
</tr>
<tr>
<td>Ability to scale down/up production</td>
<td>Ability of a plant to operate at lower capacity</td>
</tr>
<tr>
<td>INDICATOR</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>-----------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Interdependency of plant and related industries/infrastructure</td>
<td>Degree to which plant relies on other industries/infrastructure for its operation, and other industries/infrastructure rely on the plant for their operation</td>
</tr>
<tr>
<td>Infrastructure</td>
<td></td>
</tr>
<tr>
<td>Project completion time</td>
<td>Time taken to acquire a planning permit, then construct the wastewater treatment plant and related infrastructure, giving consideration to planning approval pathway and timing, zoning requirements, site preparation, ability of specialised machinery and skilled labour, connection to existing water and electricity networks.</td>
</tr>
<tr>
<td>Constructability of plant and related infrastructure</td>
<td>Degree of risk associated with the construction of the plant and related infrastructure, due to the complex nature of the some wastewater technology, any site difficulties.</td>
</tr>
<tr>
<td>Modular nature of plant</td>
<td>Ability of plant to have staged construction and future augmentation due to its modular nature</td>
</tr>
<tr>
<td>Ability to retrofit plant</td>
<td>Ability of retrofit plant with future wastewater treatment technologies</td>
</tr>
<tr>
<td>Opportunity for other applications</td>
<td>Ability of plant to be used for applications other than wastewater treatment, e.g. desalination.</td>
</tr>
<tr>
<td>Compatibility of plant location with existing and planned</td>
<td>Compatibility of the location of the plant to the location of required utilities and other infrastructure, including water mains and electricity network connections.</td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
</tr>
<tr>
<td>Greenhouse Gas emissions per kL water treated</td>
<td>Equivalent greenhouse gas emissions per kL water treated. Includes equivalent emissions from electricity usage, pumping and process</td>
</tr>
<tr>
<td>Waste handling / disposal</td>
<td>Impact of handling and disposal of site wastes on the environment. Could include positive effects if wastes can be used as soil conditioners...</td>
</tr>
<tr>
<td>Terrestrial site impacts</td>
<td>Impact of plant on surrounding terrestrial environment. Includes flora and fauna impacts</td>
</tr>
<tr>
<td>Marine site impacts</td>
<td>Impact of plant on surrounding marine environment. Includes flora and fauna impacts</td>
</tr>
<tr>
<td>Air pollution impacts (if power plant required)</td>
<td>Impact of plant on air quality. Includes consideration of air shed, weather patterns, health impact of incremental increases</td>
</tr>
<tr>
<td>Noise pollution impacts</td>
<td>Impact of plant on local noise pollution. Includes health impact of incremental increases</td>
</tr>
<tr>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td>Energy use per kL water produced</td>
<td>Amount of energy used by the process and associated pumping, including both electrical, fuel and thermal sources</td>
</tr>
<tr>
<td>Possibility for future provision of alternative energy sources</td>
<td>Ability of wastewater treatment plant to accept power from different sources in the future</td>
</tr>
<tr>
<td>Impact on energy networks</td>
<td>Impact made by wastewater treatment plant and purpose built power plant on the electricity and gas networks. Includes network stability, energy export to network, peaking issues, ability of plant to receive interrupted and curtailed power</td>
</tr>
<tr>
<td>Financial</td>
<td></td>
</tr>
<tr>
<td>Capital cost of plant</td>
<td>Capital cost of plant. Includes site preparation, construction of plant and related infrastructure</td>
</tr>
<tr>
<td>Operating costs of plant</td>
<td>Cost of operating plant. Includes desalination plant, associated pumping, water treatment, chemical costs, waste disposal costs, maintenance</td>
</tr>
<tr>
<td>Levelised Cost – Net Present Value</td>
<td>Levelised cost of an option based on its net present value over a given life span</td>
</tr>
<tr>
<td>Social</td>
<td></td>
</tr>
<tr>
<td>Impact of construction and operation on public amenity</td>
<td>Impact that construction and operation of plant and related infrastructure could have on public amenity. Includes traffic and visual impacts.</td>
</tr>
<tr>
<td>Proximity of plant to residential areas</td>
<td>Distance from plant to nearest residential area</td>
</tr>
<tr>
<td>Occupational Health and Safety</td>
<td>Risk a particular option poses to safety</td>
</tr>
<tr>
<td>Aesthetic aspects of water produced</td>
<td>Aesthetic quality of water produced for consumers. Includes taste, odour, colour</td>
</tr>
<tr>
<td>INDICATOR</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Compatibility of land use</td>
<td>Compatibility of site location with existing land use, eg. Industrial areas, residential. Includes zoning, existing use rights</td>
</tr>
</tbody>
</table>

Not all the criteria above are technical, but all are presented because they provide a good example of the kinds of criteria considered important in a large scale water project.

A challenge presented by a list of criteria, such as that shown in Table 22 becomes how to generate an overall assessment of the design. It is unlikely that a design being considered will perform better than other design in all criteria, so the designer must make decisions regarding the relative importance of each criterion as well as the degree to which a particular design meets each criterion.

### 5.2.3 Traditional Economic Assessment

One key limitation of traditional economic assessment is that it undervalues water. The argument goes that you do not know the true value of water until it runs out. Water priced in pure economic terms does not sufficiently value the potential scarcity, restrictions, and the social and environmental issues with water.

A traditional economic assessment of an alternative water resource technology project would typically involve a capital investment analysis technique that provides an indication of the financial viability of the project. Many financial analysis techniques exist for assessing a design proposal. The main ones that would apply to an alternative water resource technology will be reviewed here.

The financial performance of a project can be assessed by looking simply at these metrics, however it is possible to use more sophisticated measures that incorporate capital costs, operating costs and operating savings.

### 5.2.4 Simple payback analysis

Most financial analysis centres on three elements of a design: capital cost, operating cost and operating savings.

- The capital cost of a design includes all costs of purchasing and installing the necessary equipment.
- Capital costs are incurred once, usually at the completion of installation. In contrast to the capital cost, the operating costs include the cost of operating the installed design and are ongoing.
- Operating costs are typically maintenance, energy costs, treatment costs and waste disposal costs.
- Operating savings of a design are the beneficial impacts of mains water savings, and potentially waste reduction.
- Net operating savings of a design are often stated by subtracting operating costs from operating savings.
Simple payback allows organisations to determine if and when operating savings generated by a proposed alternative water resource technology will pay for the costs required to install and operate it. To determine the simple payback of a project, the capital cost of the project is divided by the net operating savings per annum. This will give the number of years before the savings generated pay for the capital invested in creating the project. Illustrates how simple payback is determined.

Figure 31: Simple payback period.

Simple payback is a relatively easy method to apply, hence it is frequently used by system designers, especially in early phases. As a measure for financial performance it does give an indication of the ratio of benefits to initial investment, however does not incorporate more sophisticated (and realistic) concepts such as the time-value of money and investment scale. Cash flow analysis, described in the next section, provides a more thorough basis for decision making.

5.2.5 Life cycle cash flow analysis

A more sophisticated approach involves calculating the Net Present Value (NPV) for a project over time. NPV gives you numbers that you can use to compare competing options and clarify which is the more cost effective over time. NPV will take into account WHEN money is spent as well as items such as bank interest rates and depreciation.

Usually a spreadsheet will be used to calculate the following life cycle cash flows: NPV and levelised NPV. An example of an NPV calculator can be found in the AWR PDA Tool

Net Present Value (NPV)

NPV involves determining cash flows associated with an alternative water resource technology then discounting these flows at a specific discount rate or interest rate over time. The discount rate usually reflects how the organisation values cash and often
reflects prevailing bank interest rates (especially if the project will be funded by borrowing money).

Cash flows are determined for the design, which will in most cases be similar to the capital costs and net operating costs/savings. The main difference is that sometimes operating costs over time include items that may not strictly be considered cash such as plant depreciation and amortisation. Determining the nature of cash flows may require expert assistance, which can usually be gained in-house by talking to the organisation’s accountant.

A cash flow analysis is constructed for the proposed design and the total cash flow in each year of the design life is determined. Each cash flow is then discounted to create a net present value. The higher an NPV, the better a project is. A diagrammatic representation of the NPV calculation is shown in Figure 32.

![Diagrammatic representation of the NPV calculation.](image)

**Figure 32:** Diagrammatic representation of the NPV calculation.

Cash flow analysis can be complex, and can lead to mistakes, even when used by seasoned practitioners. However it is the best determinant of financial value, because it considers the time-value of money. A mathematical definition form NPV is shown in Equation 2

**Equation 2: Net Present Value.**

\[ NPV = \sum_{i=0}^{n} \frac{CF_i}{(1 + r)^i} \]

where:
- \( NPV = \) Net Present Value
- \( CF = \) A cash flow from the project
- \( n = \) number of periods in the project
- \( r = \) discount rate for project
- \( i = \) a particular period in the project
**Levelised Net Present Value**

A limitation of the NPV method described above occurs when projects with different lives are compared. Shorter system lives will typically generate smaller NPVs than projects with longer lives. Levelised NPV addresses this by converting the NPV of a project into a per-unit (usually per kilolitre) amounts, the present value of which equals the total project NPV.

**Equation 3: Levelised NPV (LNPV) for an alternative water resource technology**

\[
LNPV = \frac{NPV}{\sum_{i=0}^{n} \frac{W_i}{(1+r)^i}}
\]

where:
- LNPV = levelised NPV in $/kL
- W = annual water supply (kL)

Although somewhat complex to calculate, the levelised cost provides a good basis for comparing projects with different lives by eliminating any bias associated with project life (refer Equation 3).

The levelised cost technique assumes that projects with shorter lives will be continuously replaced to achieve the equivalent life of longer lived projects they are compared to.

**Internal Rate of Return (IRR)**

IRR is based on NPV. You can think of it as a special case of NPV, where the rate of return calculated is the interest rate corresponding to a 0 (zero) net present value.

Organisations will often select an IRR ‘hurdle’ where a project must meet a specified internal rate of return to be considered profitable. For example an IRR set at current deposit interest rates (e.g. 8%) would be selected if the project was to generate a return that was better than putting money in the bank.

### 5.3 Environmental and social assessment indicators

Like any project, an alternative water resource technology will have environmental and social impacts that should be considered in the TBL assessment. Methodologies, such as LCA can provide detailed assessment of system environmental impacts over its life cycle (refer Appendix C - Further Resources & Tools). In smaller projects, simpler techniques such as reviewing greenhouse gas emissions and waste emissions can be used to provide quick indications of impacts.

**Table 23: Some common elements that can be considered in environmental and social assessments**
<table>
<thead>
<tr>
<th>MCA / TBL ASPECT</th>
<th>POSSIBLE PROJECT INDICATOR</th>
<th>POSSIBLE UNIT ($), # OR DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Acceptability</td>
<td>Level of opposition/support across the community</td>
<td>Stakeholder surveys</td>
</tr>
<tr>
<td>Governance</td>
<td>Development opportunities</td>
<td>Estimated $ of net opportunities</td>
</tr>
<tr>
<td>Social benefits</td>
<td>Wider social benefits from amenity, recreational and other outcomes.</td>
<td>Description</td>
</tr>
<tr>
<td>Environment</td>
<td>Net change to native ecology (flora or fauna) (loss or gain)</td>
<td>Ha / M2</td>
</tr>
<tr>
<td>Environment</td>
<td>Endangered species</td>
<td>No of species impacted</td>
</tr>
<tr>
<td>Environment</td>
<td>Effects on environmental outcomes in lakes and Rivers</td>
<td>WSUD criteria</td>
</tr>
<tr>
<td>Environment</td>
<td>Impact on environmental flow objectives (river health)</td>
<td>RH Index</td>
</tr>
<tr>
<td>Health Standards</td>
<td>Effort to ensure option meets public health standards</td>
<td>Effort required to reduce the risk rating</td>
</tr>
<tr>
<td>Health Standards</td>
<td>Effort to ensure option meets public health standards</td>
<td>(Consequence x Likelihood = Risk rating)</td>
</tr>
<tr>
<td>Compliance</td>
<td>100% compliance with EPA conditions</td>
<td>Complies Y / N</td>
</tr>
<tr>
<td>Environment</td>
<td>100% beneficial use of reclaimed water</td>
<td>Complies Y / N</td>
</tr>
<tr>
<td>Water Demand</td>
<td>Total Water demand</td>
<td>Volume (ML) / Connection</td>
</tr>
<tr>
<td>Water Conservation</td>
<td>% of Water demand</td>
<td>Volume (ML) / pa</td>
</tr>
<tr>
<td>Water Reliability</td>
<td>How well will the different options reduce future water restrictions</td>
<td>Operational Security</td>
</tr>
<tr>
<td>Community Development</td>
<td>Redistribution of costs and benefits between water use sectors, particular socio-economic groups, generations or regions / marginal benefits to those groups</td>
<td>Fairness Flag – Distribution of Costs and Benefits</td>
</tr>
<tr>
<td>Project Viability</td>
<td>Level of technical difficulty for project delivery</td>
<td>Rate ( H,M,L)</td>
</tr>
<tr>
<td>Compliance</td>
<td>Audit Report</td>
<td>Complies Y / N</td>
</tr>
<tr>
<td>Effect on Regional GDP and development</td>
<td>Immediate output reduction / expansion</td>
<td>$ Evaluation</td>
</tr>
<tr>
<td>Governance</td>
<td>Board Charter</td>
<td>Complies Y / N</td>
</tr>
<tr>
<td>Governance</td>
<td>Annual Review completed</td>
<td>Complies Y / N</td>
</tr>
<tr>
<td>Management</td>
<td>Staff retention rates</td>
<td>Staff turnover</td>
</tr>
<tr>
<td>Management</td>
<td>Staff satisfaction</td>
<td>Absenteeism, productivity increase x wages</td>
</tr>
<tr>
<td>Innovation</td>
<td>Continuous improvement</td>
<td>Quality Management System</td>
</tr>
<tr>
<td>River health</td>
<td>Impact on environmental flow objectives (river health)</td>
<td>RH Index</td>
</tr>
<tr>
<td>Partnerships</td>
<td>Net Present Value</td>
<td>$/ML</td>
</tr>
<tr>
<td>Safety</td>
<td>OHS Register</td>
<td>No of incidents</td>
</tr>
</tbody>
</table>
5.3.1 Greenhouse gas emissions from alternative water resource technologies

Electricity consumption

The greenhouse gas emissions from water supply systems tend to be caused by operational energy use, usually associated with electricity. In Victoria, most electricity is generated through the burning of brown coal, which causes significant greenhouse gas emissions which contribute to climate change. Assessing greenhouse emissions from alternative water resource technologies typically involves understanding energy consumed by the alternative water resource technology per kilolitre of water provided, then converting this consumption to greenhouse emissions using standardised factors (shown in Table 24). Emissions are typically stated in terms of kilograms of carbon dioxide equivalents (kgCO₂e), reflecting the global warming potential.

Table 24: Full fuel cycle emissions factors for electricity consumption by end users in Victoria [64].

<table>
<thead>
<tr>
<th>FUEL TYPE</th>
<th>CO₂-eq / kWh</th>
<th>CO₂-eq / MJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>1.31</td>
<td>0.3639</td>
</tr>
<tr>
<td>Gas</td>
<td>0.18</td>
<td>0.0513</td>
</tr>
<tr>
<td>LPG</td>
<td>0.18</td>
<td>0.0513</td>
</tr>
<tr>
<td>Wood*</td>
<td>0.05</td>
<td>0.0140</td>
</tr>
<tr>
<td>Diesel Oil</td>
<td>0.25</td>
<td>0.0695</td>
</tr>
</tbody>
</table>

* AGO (2005) includes N2O, transport and CH4 emissions only, not CO2 as wood is considered renewable.

Determination of emissions from an alternative water resource technology involves estimating energy use expected from the system. Energy consumption can be estimated using a number of different methods. A simple method involves looking at the total energy consumption expected from all the devices in the system when they are operating, then multiplying this by the time they are expected to operate over the course of a year.

For example, if an alternative water resource technology system contains a 400 Watt pump that will operate for about 4 hours each day, its annual energy consumption would be determined as follows:

**Equation 4: Energy use and greenhouse calculation**

\[
\text{Energy use of AWR system (in kilowatts)} \times \text{time in operation over year (in hours)} = \text{annual energy use (in kWh)}
\]

\[
\frac{400}{1000} \times 5 \times 365 = 730 \text{kWh}
\]
The emissions associated with the alternative water resource technology electricity use can then be determined by multiplying by the appropriate emissions factor from Table 24.

Using the above example, emissions for the alternative water resource technology if located in Victoria would be determined as follows:

\[
\text{Electricity consumed by the AWR (in kWh) } \times \text{ Emissions factor for state (in kg CO}_2\text{e per kWh) } = \text{ Greenhouse emissions in kg CO}_2\text{e}
\]

\[
730 \times 1.31 = 956.3 \text{kg CO}_2\text{e}
\]

Note that mega-joules (MJ) can be converted to kilo-watt hours (kWh) as follows:

\[
1 \text{ MJ} = 0.2778 \text{kWh}
\]

\[
1 \text{kWh} = 3.6 \text{ MJ}
\]

**Trucking water**

Often alternative water resource technologies will involve a transport stage that involves trucking water from one site to another. Water by its nature is heavy and therefore requires significant effort to move by road, generating substantial consequential environmental impacts. Impacts extend beyond global warming, however greenhouse gas emissions can be easily estimated and provide a good proxy for other impacts.

Estimating the greenhouse emissions from trucking water is undertaken using a similar method to that used for electricity. An emission factor for trucking is used which is multiplied by truck usage.

Trucking emissions factors are not published by the Department of Climate Change, so users must develop factors using techniques such as LCA. For this guide, an emissions factor for trucking water has been developed based on rigid truck transport as follows:

**Equation 5: Greenhouse emissions from trucking.**

\[
a) \text{ urban vehicle efficiency of 0.35 tonne-km/MJ (rigid truck, from Australian Transport Facts, Apelbaum (2001) - Table 4.2.1-6).}
\]

\[
b) \text{ greenhouse emission of 69.5 kg CO}_2\text{e/GJ of diesel consumed (National Greenhouse Accounts Factors, Dept. of Climate Change (2008)).}
\]

\[
\text{www.climatechange.gov.au.}
\]

\[
\text{Factor } = \frac{69.5}{1000 \times 0.35} = 0.2 \text{kg CO}_2\text{e per tonne.km}
\]

Using the factor developed in Equation 5 it is easy to estimate emissions from trucking water if the amount of water and distance travelled is known. For example, an estimate of emissions associated with trucking 3 kilolitres of water 5 km would be determined as follows:
Amount of water (kL) x density of water (1.0)
 x distance travelled (km) x emissions factor for trucking
= greenhouse gas emissions from trucking (kgCO₂e)

\[ 3 \times 1 \times 5 \times 0.2 = 3 \text{kgCO₂e} \]

Trucking can be a surprisingly significant contributor of greenhouse gas emissions in an alternative water resource technology, especially if trucking distances are significant, so is worthwhile assessing.

### 5.3.2 Desalination benchmark

Calculation of greenhouse gas emissions associated with alternative water resource technology designs allows for differentiation between design, but in isolation does not provide guidance as to whether the design is effective versus other municipal alternatives. In order to assess this it is necessary to consider where an incremental unit of water supply would come from if the alternative water resource technology were not to build, and the impacts this would cause.

As discussed earlier in this guide (Section 2.1) Australia’s water supply situation is constrained by lack of rainfall, which cannot be addressed by building catchments. If water efficiency cannot be improved then additional water supply options are limited. One of the options being considered by many Australian capital cities is the installation of desalination plants that convert sea water to drinking water using electrical energy.

Desalination is typically an energy intensive process (although systems have been becoming more efficient), so it probably represents a good benchmark against which to compare a proposed alternative water resource technology.

Desalination typically requires 5kWh per kL to process \[45\], so if powered from electricity in Victoria would generate 6.55 kgCO₂e/kL (5x1.31 from Table 24). If an alternative water resource technology proposed generates more greenhouse gas emissions than this benchmark, then it could make more sense, from a climate change perspective, to build a desalination plant instead of the alternative water resource technology.

Desalination as a benchmark is introduced to give some perspective to the global warming impacts of alternative water resource technology designs, however it is not intended to be the sole decision driver. The TBL assessment considers a wider range of issues, each of which should be addressed in the decision making process.

### 5.3.3 Other environmental impacts of alternative water resource technologies

In addition to contributing to greenhouse gas emissions through electricity use and trucking, alternative water resource technologies are likely to have other environmental impacts, such as waste generation. The impact of wastes generated (or avoided in some cases) is usually best assessed using a technique like LCA, which can take into account the quantity and substance of waste generated. In the absence of LCA capability, as
might be expected in an early feasibility review, it can be useful to simply review the quantity of wastes generated.

Considering and documenting waste amounts generated can help the assessor differentiate between designs being considered based on their propensity to generate waste, so is useful in a TBL assessment. If mass data can be combined with descriptions of the waste generated, then the combination can provide a more useful point to distinguish alternative water resource technology designs.

Alternative water resource technologies may also generate other impacts in addition to waste which should be considered in a TBL assessment. Even if these impacts are not fully understood, flagging a potential environmental impact associated with a design, contributes to transparency, and is better than leaving the issue out of the assessment.

5.4 Social assessment

In addition to economic and environmental aspects, the TBL framework also considers social impacts of the proposed design. Typically, the social implications of the TBL are often the most difficult to quantify, hence present the greatest challenge of the three bottom lines when it comes to assessment.

In this guide, alternative water resource technology design elements that affect the “public good” have been considered part of the social bottom line, although arguably some could also be considered questions of economics, given the potentially severe monetary implications. The list of alternative water resource technology social aspects presented below is not exhaustive, and many alternative water resource technology designs would arguably engender other social impacts that should be assessed. The key to the social bottom line assessment is to take the time to consider and address often overlooked social implications of system design and allocate to them similar levels of importance as are allocated to the other bottom lines.

5.4.1 Risk assessment

Human health and environmental outcomes are arguably key considerations of any alternative water resource technology design. The implications of problems in these areas would impact each bottom line in the TBL assessment, so risk could easily be addressed under economic or environmental categories. In this guide, risk assessment has been placed in the social category due to the significant equity communities have in issues of human health and environment.

Risk assessment is integral to determining how an alternative water resource technology will be utilised, and what the resulting water will be used for. Certain sources and applications will attract higher inherent risks than others, all of which must be mitigated to acceptable levels by the intended alternative water resource technology design. Assessment of designs can therefore utilise the outputs of risk assessment discussions, both at preliminary stages and after designs emerge.
Risk assessment outputs can take various forms, however typical outputs involve ratings, such as High, Medium and Low. These can be used directly in the TBL assessment to compare design options. Often risks will be split between ‘inherent’ (those associated with the fundamental alternative water resource technologies and applications selected), and ‘post management’ or ‘residual’, being those risks remaining once design and management controls have been applied to mitigate the inherent alternative water resource technology risks. Both summary risk types are worthy of inclusion in the alternative water resource technology assessment.

5.4.2 Social acceptability of Alternative Water Supplies

There have been numerous studies into the social acceptability of alternative water resources [46, 47], however these have been aimed primarily at consumer attitudes towards using recycled water in and around homes (both potable and non-potable water).

A study has recently been conducted examining the attitudes of employees towards using recycled water within their workplace [47]. This is believed to be the first of its type in Australia, and it focuses on the attitudes of Melbourne City Council employees towards the use of recycled water derived from sewer mining in their new office building, CH2. The results indicate that occupants who were about to move into the new building were happy to accept recycled water in certain applications such as the cooling towers, toilet flushing and garden use, however their acceptance declined as the water use had higher human contact, such as washing hands and showering. The results also showed that occupants who were more informed about environmental issues and, in particular, water recycling systems, were more likely to accept the system.

On the contrary, case studies from around the world consistently indicate that, by increasing community participation and education levels, especially at an early stage of alternative water resource projects, the community is likely to be accepting of the project [48]. These studies, however, do not deal with social acceptability of alternative water resources for use in commercial, industrial and institutional applications. Nevertheless, they do illustrate the importance of social capacity, ownership, consultation and involvement [49].

It has been shown that to attain long-term public support for alternative water resource projects it is essential to involve the community prior to any proposal of such projects [50]. Through this, community views, feelings and reasoning behind potential barriers towards alternative water resource projects can be understood. This also has benefits in terms of savings in time, money and success of the project. In addition, the report suggests that the more educated the community is about the issues surrounding the proposal, and the more the advantages and disadvantages of different options are discussed and clearly presented, the more likely projects are to receive support. The community needs to feel that concerns are being heard and dealt with, especially regarding risk management and health concerns. Hence, effective community involvement is likely to be important in determining the success of any alternative water resource project.
A recent study has shown that acceptance of alternative water supply systems can be assessed, and the assessment used to guide user engagement programmes [51]. The study also found that perceptions of alternative water supply systems, in a residential context, are complex and that emotional responses to wastewater recycling are strongly countered by cognitive responses regarding water supply sustainability.

“…acceptance ratings for these schemes also suggest that the seemingly unpalatable connotations of reusing wastewater are countered to a large extent by the cognitive perceptions of what such a system will deliver – long-term, sustainable water supplies.” [51]

While social acceptance of alternative water resources as a topic in the literature invariably relates to community projects, acceptance within commercial, industrial and institutional applications may be expected to follow a similar pattern. If employees are involved in the planning of alternative water resources and empowered to consider the need and risks involved in implementing a new system, social acceptance can be expected to increase. Hence, as communities and employees become better educated about environmental issues through the media, new technologies, their workplace and life experiences, social acceptance of more sustainable methods and technologies will improve.

5.4.3 Social benefits

A common application of alternative water resource technologies is becoming the provision of water for public uses such as the watering of sporting facilities or the provision of water for gardens, fountains and ponds. These uses and others provide social benefits that are difficult to quantify in monetary terms, however are significant nonetheless.

Another, key social benefit of utilising alternative water resource technologies is the reduction in the use of the mains water supply. This benefit may seem obvious, but by reducing demand in cities can free up water for competing uses such as growing food.

One of the strengths of the TBL assessment method is the scope to formally include social benefits associated with a project, that might otherwise be displaced by discussions regarding project economics. In an alternative water resource technology context, the social benefits are often significant and need to be stated, even if only qualitatively.

5.5 Regulatory assessment

Regulatory compliance is a legal requirement which benefits society, so can be categorised as a contributor to the social bottom line. It is also a requirement that must be met for an alternative water resource technology to be considered a realistic option.

Determining regulatory compliance in alternative water resource technology projects can be difficult, as there are a number of applicable laws and government departments
engaged in regulation. A summary of legislation applicable to water is listed in Appendix C - Further Resources & Tools.

5.5.1 EPA Approvals

Alternative water projects are usually managed in accordance with EPA guidelines and relevant Australian Standards. In Victoria, the EPA will need to approve most alternative water systems. This process allows the EPA to review projects to ensure that onsite systems are sustainable and protect public health, environmental values and community amenity. Be aware that EPA and local authority approvals can be a very slow process, so start consulting with these organisations early in the process.

Approvals Process:

For systems < 5000 litres per day:

- Approval for the system will also be needed from the local council in the form of a ‘Septic Tank Permit’.
- Most commercial systems get pre-approved for use by the EPA so only the council needs to approve the installation of the system for each site.

For systems > 5000 litres per day and for using reticulated recycled (third pipe) water:

- Usually, a design needs to be reviewed by a third party to ensure that it will comply with legal requirements. Third parties can be those engineering firms, or regulatory bodies such as the EPA.
- See: EPA Publication 760 – *Guidelines for Aerated On-site Wastewater Treatment Systems*; EPA Publication 500 – *Code of Practice for Small Wastewater Treatment Plants*; and EPA Publication 464.2 – *Guidelines for Environmental Management: Use of reclaimed water*

EPA ensures that systems that are approved comply with relevant technical standards, have had their performance independently verified and are supported, as needed, by appropriate operating, maintenance and monitoring regimes. These requirements apply to all systems.

When capturing the assessment of regulatory compliance within the TBL, the outcomes of ‘complies’, ‘does not comply’ or ‘unknown’ are likely to those that are recorded.
6 IMPLEMENTATION EXAMPLES

6.1 CH2 six star green building

Melbourne City Council's new CH2 building is a world leader in green buildings and shows what can be done with commitment to the state best practice. The building incorporates many beneficial energy efficient and low environmental impact technologies and design elements.

As a result, CH2 has become Australia’s greenest building; the first to obtain a 6 star Green Star rating from the Green Building Council of Australia. The environmental footprint is much lower than a standard building.

The new water treatment system collects all wastewater from the building and supplements this with wastewater drawn from the city sewer system. This ‘sewer mining’ aimed to allow the onsite system to clean up to 100kL/day for recycling, thus reducing mains water supply by 72%. It appears afterwards that this system is facing difficulties that make it unable to treat the water properly.

This case-study illustrates how complex can be the recycling of blackwater on-site. The aim of CH2 was to show the best practice in terms of sustainable building, but some challenges are still to be faced on that project.

Context

The decisions to build CH2 originated with the need for more office space. Rather than build a conventional building, Melbourne City Council seized the opportunity to demonstrate its commitment to sustainability.

Sustainable technologies are evident throughout, from the sewer-mining plant in the basement, phase-change materials for cooling, automatic night-purge windows, chilled beams, and a façade of louvers (powered by photovoltaic cells) that track the sun.

The project

On-site treatment (‘water mining’ or ‘sewer mining’)

CH2 PROJECT HIGHLIGHTS:

- World leadership doesn't have to cost the earth
- Water mining — reclaiming water from public drains — is much more complex to implement than it looks like,
- By using readily available AAAA fittings and good design, water use savings in offices can be significant
- Even sprinkler system test water is saved and reused
- 72% water supply savings make CH2 an example for other office buildings to follow
A laser drill was used to provide access to a City sewer main from the basement of the building. About 100,000 litres of water a day is extracted from the main sewer through this link. The sewer water typically contains 95 per cent water, and the ‘water mining’ technology allows the removal of this water, while returning the solids to the sewer system. Figure 33 shows a diagram of the sewer mine process.

Figure 33 diagram of the sewer mine process

The key technology in the water mining systems is the Membrane Water Re-Use (MWR) water treatment technology. This is essentially a three-stage filtration process:

- **a 200-micron pre-screen**: this filter is mainly used to remove gross suspended solids, oil and grease; it is periodically washed with water sprays back to the sewer;
- **a dual-membrane ultra-filtration stage**, using a cross-flow configured tubular ceramic membranes with pores around 0.02 micron; it is used to remove the bulk of the bacteria and viruses, solids are periodically washed back to the sewer
- **a reverse osmosis process**: semi-permeable membrane used to remove the remaining dissolved solids, organics, etc.

The principal issue for choosing this treatment was that MWR is compact, largely chemical free, and low-maintenance in operation. *This filtering system is currently facing some trouble*, it appears that the solid particles, and especially the toilet paper is blocking the filters. It is interesting to note that in the case of blackwater, the smallest detail can have some important consequences.

### 6.1.1 Water management in CH2

The MWR plant water and rain water collection will supply all CH2s non-drinking water needs, including water cooling, plant watering and toilet flushing. Excess treated water will be used in other council buildings, city fountains, and gardens. Using the MWR system will reduce CH2 mains water supply requirements by 72%. Of course, sink and toilet wastewater from CH2 is also fed into the MWR for recycling.

In addition, CH2 is designed to be a low water use building. To reduce water consumption, all water fittings have AAAA ratings, all toilets are dual flush, and all urinals have sensor-triggered flushing. About 25 per cent of potable (drinking) water will come from the sprinkler system used for fire safety. Safety regulations require that sprinkler systems are tested regularly and this typically involves discarding large quantities of clean drinking water. In CH2 this water will be collected and used.
**Learnings and outcomes**

Presented with the need to find more office space, Melbourne City Council took the initiative to put its environmental credentials into action with a building that was at once innovative, creative, technologically advanced, and environmentally sustainable, while setting an example for others to copy.

While CH2 did cost slightly more than a ‘standard’ building, it dispels the myth that new technologies and sustainable buildings are too hard or costly. But with this project arose the question of the relevance of a sewer mine system. It seems that blackwater treatment on site can sometimes be extremely complex.

The ‘payback’ for CH2 is estimated to be 10 years. However, in the meantime, further benefits from day one include:

- increased workplace effectiveness;
- lower costs for other public infrastructure; and
- the value of building as a guiding light in sustainable buildings.

<table>
<thead>
<tr>
<th><strong>Key Statistics</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
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<tr>
<td>Type of operation</td>
<td>Offices</td>
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<tr>
<td>Project type</td>
<td>Green Building</td>
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<tr>
<td>Start and completion date</td>
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<td>100kL/day</td>
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<tr>
<td>Water treated</td>
<td>100kL/day</td>
</tr>
<tr>
<td>Other environmental issues</td>
<td>Not assessed</td>
</tr>
</tbody>
</table>
6.2 **Dye waste minimisation through recycling & substitution**

Rethinking the dye bath management process led Bulace Dyeing, a long-established textile dyeing company based in Ballarat to cut water use and practise waste minimisation in the process. Dye bath recycling and salt load reduction were the key to the project, which was undertaken in support of Central Highlands Water’s effluent reuse objectives.

As a result, Bulace Dyeing, with EPA Victoria and Central Highlands Water, has significantly reduced potable water use and wastewater production per unit of output.

**Context**

The original project idea arose in October 2003, when Central Highlands Water approached Bulace Dyeing. Committed to reducing unrestricted potable water demand through its Demand Management Strategy, Central Highlands Water was keen to pursue this potential through an updated trade waste agreement.

The idea became a reality after Central Highlands Water and the Environment Protection Authority established a cleaner production partnership in September 2004, and invited Bulace Dyeing to collaborate in a project to minimise sodium discharges and potable water demand.

Bulace Dyeing services both local and international clothing manufacturers with a short run and quick turnaround dyeing service. The company is also committed to continuous improvements in processes, and so became enthusiastically engaged with the water reuse project.

Among the challenges was the issue of salts in the dye water, and solving this proved the key to unlocking the water savings which were eventually achieved through the project.

**The project**

Through the cleaner production partnership, initial investigations led to the identification of three separate sub-projects and these are presented below. Together, these initiatives provided for considerable reductions in Bulace Dyeing’s water consumption and trade waste contaminant load.

**Dye bath reuse**
The largest dye bath on site typically contains sodium chloride, sodium carbonate, sodium hydroxide and potable water. The initial potential to reuse this solution in dying processes up to six times, although beyond this dye quality began to drop. To improve reusability, a purpose built flocculation and filter system was incorporated, comprising a stainless steel deck lined with recycled paper. The use of gravity rather than pumps and filter paper from material previously disposed of to landfill provided additional environmental benefits.

The new system allows the dye bath solution to be reused more than 100 times, leading to a significant water savings.

**Salts and substitution**

Conventional dying processes require an electrolyte to be added to the dye bath in order to enable the dye to bind to the fabric on an atomic level. This electrolyte is typically sodium-rich.

Following initial research into potential alternative low sodium dyestuffs, Bulace Dyeing conducted laboratory trials to determine if potassium could be substituted for sodium and if so, how efficiently it would work. In theory, it may be expected to be more efficient than sodium-rich electrolyte.

The trials results affirmed the theory, and showed that, due to the increased efficiency, the recycled dye bath solution only needed filtering one in every twenty cycles instead of every six. Product quality was maintained, and the extra efficiencies mean that the substitution is viable despite an increase in price of use of the substitutant.

**Water conservation**

The options for reuse of wastewater from the dyeing process were the next consideration. Two challenges were presented here; quality of the wastewater after any processing, and cost. The effective removal of residual colour was critical to suitability of the wastewater, and initial estimates arrived at jointly by Central Highlands Water and Bulace Dyeing suggested that up to 80% of the total daily volume of trade waste could be collected and treated to a suitable quality for onsite reuse. Figure 34 shows the effluent recycling system implemented by Bullace.
Using funding from the “Stormwater and Urban Water Conservation Fund”, Bulace Dyeing (with the support from cleaner production partners) then designed and constructed the full-scale water recycling system capable of recycling 42 kilolitres of trade waste each day. Since commissioning in September 2005, Bulace Dyeing now reduces up to 80% in potable water demand through recycling of the dye water see Figure 35.

Figure 34 Bulace effluent recycling system

Figure 35 Potable water demand (McGregor. J., 2006, Trade Waste Minimisation through Recycling and Substitution)
**Learnings and outcomes**

As a small business, the case could easily be made that Bulace Dyeing lacked the resources to investigate and implement innovative environmental solutions. However, the combination of enthusiasm, cleaner production partnership and some government funding led to positive outcomes. The willingness to experiment and work with regulators and service providers was critical to this success.

In consultation with Central Highlands Water, Bulace Dyeing has developed an improved understanding of its operational efficiency, particularly regarding water use. In a logical, stepwise process, and by remaining true to the EPA’s waste hierarchy, discoveries were made that dye bath solution could be re-used and that the wastewater could be reclaimed through the addition of cost-effective treatment and management practices.

Perhaps most importantly, the challenge of reducing sodium loads brought about a major rethink in the dye chemicals used. Various methods of reducing salt loads were considered, however it was found that most involve expensive treatment, such as reverse osmosis, or membrane filtration.

The chemical switching solution devised here led to the maintenance of high product quality, while achieving savings in overall costs and major benefits in reduced environmental loads.

The key learning from the project is that, through partnerships and rethinking basic processes, business can develop a comprehensive understanding of its environmental footprint, and act to improve outcomes for both the business and the environment. From power consumption to waste disposal, the project culminated in a flexible, efficient and financially sustainable alternative.

The project demonstrates that a company’s ability and willingness to embark on a major rethink of long-term historical practices can lead to significant opportunities, with benefits for the environment and the financial bottom line.

<table>
<thead>
<tr>
<th><strong>Key Statistics</strong></th>
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</tr>
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<tbody>
<tr>
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</tr>
<tr>
<td>Project type</td>
<td>Recycling and substitution</td>
</tr>
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<td>Start and completion date</td>
<td>October 2003 - September 2005</td>
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<tr>
<td>Reticulated water savings</td>
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<tr>
<td>Water reuse</td>
<td>42 kL per day</td>
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<tr>
<td>Water treated</td>
<td>Not assessed</td>
</tr>
<tr>
<td>Other environmental issues</td>
<td>Not assessed</td>
</tr>
</tbody>
</table>
6.3 Reducing water use and increasing water recycling

Ensign Services is one of the largest Australian textile rental and industrial laundry organisations and is part of the Spotless Group.

Implementing new washing machines and new technology on older washing machines, has allowed Ensign Services to reduce their water use and increase their water recycling use.

By introducing a combination of new machines and new technology to older machines, Ensign has been able to reduce their water usage dramatically through a consistent approach over 5 years. In turn, this has also helped to reduce wastewater discharges and the need to treat water before it is released into the sewer system.

Context

The company also owns all the clothing and linen that customers use. They provide a complete service for collection, washing and return for a wide range of customers, including Ford, BHP, MasterFoods and Cadbury.

Ensign has a number of sites around Melbourne and Victoria. This case study centres on the site in Northcote. Ensign has indicated that a number of their other sites are currently, or have recently, successfully implemented water saving changes.

The water conservation and recycling initiatives in this project originally stemmed from general awareness of limits to water supply, and the specific issue of costs and volumes in treating wastewater. Ensign realised that they were in a position to save large amounts of water and help the environment while also reducing their water costs.

Among the challenges to water conservation and recycling for Ensign are space, locations, and different demands for different wash types. Overcoming these has had major benefits; implementing a range of changes over the past 5 years has cut water usage by almost 50%.

The project

Unsurprisingly, the majority of water use on site is in wash processes, either continuous batch washers or washer extractors, depending on the product. Different materials and garments require different washing techniques and times as well as different drying and storage operations. The washing machines at the Northcote site use a 10 stage washing
process. Water from these machines is discharged to the sewer via a CO2 treatment plant that removes solids, cools the wastewater, and adjusts the pH.

**New machines**

Replacing machines before the end of their service life is a decision involving trade-offs between the benefits of obtaining new water-saving technologies in the new machines, and the loss of remaining life when older machines are replaced. Each decision has both environmental and cost implications, with new machines costing in the range $500,000 to $1.5 million.

Ensign had a number of older washing machines on site, which use up 30 l/kg depending on the product being washed. New machines can reduce water use to around 7 l/kg, although Ensign estimate that the typical average for their new machines is about 14 l/kg. Hence, the new machines have the potential to save 50-70% of water over the older machines. The new machines typically originate in Europe or the USA, where water is more expensive and water efficiency is an important business consideration.

**The Aquamiser**

Another method to help save water is with the Aquamiser, a device common to new machines, but which can also be retrofitted to older machines. The Aquamiser is used to filter the water, allowing water from different stages of washing to be recycled where possible. Typically, water from the first few stages cannot be recycled economically as it is the dirtiest, whereas that used in the later, cleaner stages can be filtered back for reuse in earlier stages. Figure 36 shows the Aquamiser system.

![Figure 36 Aquamiser process (source: http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-6_Water_recycling.PDF)](http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-6_Water_recycling.PDF)

*Water extraction technology*
Older technology would often leave the garments at the end of the wash cycle still containing up to 50% water content. The introduction of new water extraction technology reduces final (clean) water holding content to about 35%. This means that 65% of the final clean water can be recycled through different stages using Aquamiser. Hence, the reduction in water content has led to more water being recycled – plus less time and energy being spent on drying the garments.

**Process and maintenance**

Other initiatives include making sure that all loads are at maximum capacity so that water is not wasted. Loads are now weighed to make sure that they are as close to full as possible. Ensign also ensures that they have regular maintenance to make sure all machines and processes are running as efficiently and effectively as possible.

**Learnings and outcomes**

Ensign is saving water for environmental reasons. The company did not have significant cost savings in mind at the outset of the project. The price of water is currently relatively low compared to the price of washing machines. However, Ensign have realised that they can save a great amount of water and have implemented several initiatives to do this.

Through a combination of updating older machinery and buying a new machine, Ensign has been able to reduce water use over the past 5 years by almost 50%. The company is continuing to look at how to further reduce water use and increase water recycling.

Ensign is an example of what a company with limited space and a tight budget can do. The spin-offs include improved machine use efficiency, time and labour savings as well as energy savings. The project illustrates that a good environmental management and a pro-active approach to water management makes business sense even when it is not cost-driven.

**Key Statistics**

<table>
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<tr>
<th>Key Statistics</th>
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<td>Laundry</td>
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<td>Project type</td>
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<td>Start and completion date</td>
<td>On going</td>
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<td>Reticulated water savings</td>
<td>Almost 50% in past 5 years</td>
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<tr>
<td>Water reuse</td>
<td>Up to 65% for some</td>
</tr>
<tr>
<td>Water treated</td>
<td>Not assessed</td>
</tr>
<tr>
<td>Other environmental issues</td>
<td>Not assessed</td>
</tr>
</tbody>
</table>
6.4 Water reduction through improved efficiency

Chadstone Shopping Centre is a major regional shopping centre with almost 400 shops and businesses onsite and an estimated traffic rate of 17 million people per year. The daily consumption of water on-site was originally of approximately 400 kL.

By working in partnership with Yarra Valley Water, Chadstone Shopping Centre conducted a site audit and created a Water Management Plan. Two other projects are to be implemented, a rainwater collection system and a greywater collection system.

This project shows how large, complex sites can achieve considerable water and trade waste savings.

**Context**

The shopping centre is still expanding each year with an annual traffic increase of 2-3%. Chadstone Shopping Centre is recognised around Australia and is noted for being a ‘fashion capital’ retail outlet.

With the size of such a facility and the continual expansion, resource use continues to grow. The Water Management Plan was implemented in late 2003, and led to an approximate 15% reduction with an 8 months payback period.

Among the challenges to water reduction were the size of the site, the number and range of tenants with their different water requirements, the high numbers of people visiting the site, and the continuing growth in both facilities and visitors.

**The project**

Water management plan

Initial investigations from the audit and subsequent Water Management Plan identified four key areas where water savings could occur:

- **Pressure reduction devices**: the implementation of pressure flow control valves were fitted to all taps, faucets and showerheads, leading to a reduction of around 28,000 kL/year;
- **Waterless urinals** installed led to an estimated water reduction of 18,000 kL/year;

**CHADSTONE PROJECT HIGHLIGHTS:**

- Even on large retail sites with many tenants and users, significant water savings can be made
- Cost is not necessarily a barrier – the Chadstone savings project has a pay back of less than a year
- Teaming up with Yarra Valley Water through its Save Water programme helped ensure success of the project
- People are important – keeping everyone informed and empowered is critical in large, complex sites like Chadstone
• **Irrigation rain sensors** are a device that prevents automatic irrigation system or sprinkler system from turning on during and after rain; their implementation led to the saving of 10,000 kL/year

• **Tenant education** project has been implemented, to gather the supports of the tenants

The following graph, Figure 37, shows the reduction in water usage after implementing the water reduction actions.

![Chadstone Shopping Complex Water Efficiency Model](chart.png)

**Figure 37 Chadstone Shopping Complex reduction in water usage after implementing water reduction actions (Greenall. C., 2006, Chadstone – The Fashion Capital, Case Study – Water Savings. Presentation at B.A.T.E. March 30, Carlton.)**

Rainwater collection system

A new project of implementation of a rainwater collection system is to be implemented at the end of 2009. The roof of the Complex represents a surface of 12,000 m². The expected amount of water collected will be 700 kL/year.

The system will be relatively simple, and divided in four parts:

• a collection system;
• a sand filter;
• a water tank; and
• a redistribution system.

The water collected will be used to flush the toilets and to irrigate the gardens.

Greywater collection system

Following the rainwater collection system, the implementation of a greywater reuse system is also planned for Chadstone in 2010. The project plans to collect 6000 L/day of greywater from the basins and showers.

The water collected will be treated to reach class A standard, and then used to flush the toilets and to irrigate the gardens.
Learnings and Outcomes

Chadstone is one of the largest retail facilities in Australia and has a wide range of tenants with a wide range of needs. In addition, there are a large number of customers who pass through the doors every day. With such a site size and range of needs, it would have been tempting for Chadstone to decide it would be too difficult to significantly reduce water usage.

However, with help from Yarra Valley Water, Chadstone found ways to take the first important steps in meeting environmental challenges through reducing water use. Positive spinoffs included financial savings (reduced usage, reduced maintenance and energy savings) and positive media for the shopping centre. This positive outcome led Chadstone shopping centre to push to project further and implement a rainwater collection system and a greywater reuse system, to continue improving the water system on-site.

The key learning from this project has been that, no matter how large, complex or diffuse is the situation, with careful planning and a desire to improve environmental standards, positive changes can occur.

<table>
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<td>Retail</td>
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<td>Project type</td>
<td>Water efficiency</td>
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<td>Start and completion date</td>
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<td>Water reuse</td>
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<td>Water treated</td>
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<td>Other environmental issues</td>
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</table>
7 Conclusion

This Guide has intended to provide an overview of alternative water resources and their application in non-residential applications. It has attempted to summarise the principles of alternative water resource system development, and provide mechanisms, such as the AWR PDA Tool, that allow alternative water resource technology options to be comprehensively assessed, early in the design process.

The use of alternative water resources supports the principle of “All water resources are valuable” articulated in the Victorian Government’s White Paper on the future of water resources. It is hoped that by using this Guide those engaged in the development of non-residential projects will maximise the opportunities associated with alternative water resources, thereby contributing to the sustainability of Victoria's water supply.
8 Sources


Case Study Sources:

[1]: [http://www.watemunc.com/fr/otv03.htm](http://www.watemunc.com/fr/otv03.htm)


APPENDIX A - WATER CONSULTANTS OPERATING IN VICTORIA

Below are the details of some of the water consultants operating in Victoria who are available to provide further information on water reuse and recycling plant design, operation, sizing and installation.

Table 25: Water Consultants Operating in Victoria

<table>
<thead>
<tr>
<th>NAME</th>
<th>LOCATION</th>
<th>WEBSITE</th>
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</thead>
<tbody>
<tr>
<td>Connell Wagner</td>
<td>Melbourne</td>
<td><a href="http://www.conwag.com">www.conwag.com</a></td>
</tr>
<tr>
<td>Coomes Consulting Group P/L</td>
<td>South Melbourne</td>
<td><a href="http://www.coomes.com.au">www.coomes.com.au</a></td>
</tr>
<tr>
<td>EnviroSmart Living</td>
<td>Sunbury</td>
<td><a href="http://www.envirosmartliving.com.au">www.envirosmartliving.com.au</a></td>
</tr>
<tr>
<td>Earth Tech</td>
<td>Melbourne</td>
<td><a href="http://www.earthtech.com.au">www.earthtech.com.au</a></td>
</tr>
<tr>
<td>Edge Synergy</td>
<td>Collingwood</td>
<td><a href="http://www.edgesynergy.com.au">www.edgesynergy.com.au</a></td>
</tr>
<tr>
<td>FSA Consulting VIC</td>
<td>Horsham</td>
<td><a href="http://www.fsaconsulting.net">www.fsaconsulting.net</a></td>
</tr>
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<td>GHD Pty Ltd</td>
<td>Melbourne</td>
<td><a href="http://www.ghd.com.au">www.ghd.com.au</a></td>
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<td>Hyder Consulting</td>
<td>Melbourne</td>
<td><a href="http://www.hyderconsulting.com">www.hyderconsulting.com</a></td>
</tr>
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<td>Maunsell</td>
<td>Melbourne</td>
<td><a href="http://www.maunsell.com">www.maunsell.com</a></td>
</tr>
<tr>
<td>Organica Engineering</td>
<td>Belgrave</td>
<td><a href="http://www.organicaeng.com.au">www.organicaeng.com.au</a></td>
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<td>PBJ &amp; Associates</td>
<td>Blackburn</td>
<td><a href="http://www.pbj.com.au">www.pbj.com.au</a></td>
</tr>
<tr>
<td>PMP Environmental</td>
<td>Lilydale</td>
<td><a href="http://www.pmpenv.com">www.pmpenv.com</a></td>
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<td>The Environmental Edge</td>
<td>Coburg</td>
<td><a href="http://www.eedge.com.au">www.eedge.com.au</a></td>
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<td>Thiess Services</td>
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<td>WJ Pratt</td>
<td>Doncaster</td>
<td><a href="http://www.wjpratt.com.au">www.wjpratt.com.au</a></td>
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APPENDIX B – AUTHORITY CONTACTS

For further information, contact the following organisations.

<table>
<thead>
<tr>
<th>NAME OF ORGANISATION</th>
<th>CONTACT DETAILS</th>
<th>WEBSITE</th>
<th>BRIEF DESCRIPTION ABOUT ORGANISATION</th>
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<tbody>
<tr>
<td>EPA Victoria</td>
<td>GPO Box 4395QQ&lt;br&gt;Melbourne&lt;br&gt;Victoria 3001&lt;br&gt;Telephone: (03) 9695 2722</td>
<td><a href="http://www.epa.vic.gov.au">www.epa.vic.gov.au</a></td>
<td>EPA Victoria is a statutory authority and was established under the Environment Protection Act 1970. It exists to ensure the protection, care and improvement of beneficial uses of the air, land, water and the general environment through the implementation of guidelines, policies and regulations.</td>
</tr>
<tr>
<td>Department of Sustainability and Environment</td>
<td>8 Nicholson Street&lt;br&gt;East Melbourne&lt;br&gt;VIC 3002</td>
<td><a href="http://www.dse.vic.gov.au">www.dse.vic.gov.au</a></td>
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<tr>
<td>Melbourne Water</td>
<td>PO Box 4342&lt;br&gt;Melbourne VIC 3001&lt;br&gt;Australia&lt;br&gt;Telephone: 131 722</td>
<td><a href="http://www.melbournewater.com.au">www.melbournewater.com.au</a></td>
<td>Melbourne Water is owned by the Victorian Government. Melbourne Water is a significant business, responsible for managing $8.4 billion in water supply, sewerage and drainage assets. Melbourne Water is committed to looking after these assets in a way that protects and improves their environmental, social and financial values.</td>
</tr>
<tr>
<td>City West Water</td>
<td>City West Water Limited&lt;br&gt;Locked Bag 350&lt;br&gt;Sunshine VIC 3020&lt;br&gt;Telephone: 131 691</td>
<td><a href="http://www.citywestwater.com.au/">http://www.citywestwater.com.au/</a></td>
<td>City West Water is one of three retail water businesses in metropolitan Melbourne owned by the Victorian Government. City West Water's boundaries contain the local government areas of Brimbank, Hobsons Bay, Maribyrnong, Melbourne (north of the Yarra River), Moonee Valley, Wyndham, Yarra and parts of Melton and Hume.</td>
</tr>
<tr>
<td>Other water authorities</td>
<td></td>
<td></td>
<td>These water authorities provide drinking water, water catchment management, trade waste, sewage treatment for their rural Victorian regions. They also supply water for residential, commercial, industrial and agricultural purposes.</td>
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<td>Local city councils</td>
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<td></td>
<td>Local city councils planning departments are responsible</td>
</tr>
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<td>NAME OF ORGANISATION</td>
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<td>WEBSITE</td>
<td>BRIEF DESCRIPTION ABOUT ORGANISATION</td>
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</tr>
<tr>
<td>planning departments</td>
<td></td>
<td></td>
<td>for a range of services that manage the city's land use and physical environment, including water. Local councils aims to provide a fully integrated urban planning service, focused on establishing a strategic direction for future development. This includes protecting and maintaining the environment. Local council planning departments deal with waterways as well as with water distribution and sewerage planning.</td>
</tr>
</tbody>
</table>

Planning departments online/70973-Victoria-Online-Local-councils.html (from this link you can access all local Victorian councils and access their planning departments)
Design and Assessment Tools
A number of guides exist to help water users broadly improve the effectiveness of water use and to guide aspects of alternative water system design (alternative water resource technology) design. Included in these guides, which are often residence focussed, will usually be recommendations regarding alternative water resources. The City of Melbourne’s guide Water Sensitive Urban Design Guidelines [52] that advocates a four point design strategy informed by four guiding principles:

- reduce water consumption;
- reduce wastewater;
- maximise water reuse; and
- treat stormwater before discharge to the aquatic environment.

All this can be achieved by following the guiding principles:

- demand management - reducing the demand for water in our homes, and businesses;
- 'fit-for-purpose' water use - using appropriate quality water for the appropriate purpose;
- alternative urban water sources – rainwater harvesting, greywater reuse and blackwater reuse; and
- applying stormwater best practice environmental management.

Beyond ‘guiding principles’, the quantification of environmental benefits provided for by alternative water resource technologies is uncommon in the mainstream literature.

Life cycle assessment (LCA)
Many water authorities have identified the potential to reduce the environmental impacts of their operations as well as those of users of their water [53], although the identification of precise environmental savings is often complex. LCA can assist, as it is generally used to assess the environmental impacts and issues arising from a product or service across its life cycle, including provision of raw materials through to disposal or reuse. LCA has been defined as follows:

“Life cycle assessment is the analysis and assessment process examining environmental impacts of a product, process or activity” [54].

LCA has its roots in energy analysis in the 1960s. The international ISO Standard 14040 [55] identifies four key steps in undertaking LCA: Goal and Scope definition, Inventory analysis, Impact Assessment, and Interpretation.

Application of LCA to alternative water resources
LCA is particularly useful when considering alternative water resource technology options in new residential or non-residential applications. The ability of the technique to quantify environmental impacts in an objective manner adds weight to environmental aspects leading to better, more balanced decisions. In particular, LCA allows decision makers to
quantify the impacts associated with water supply or treatment infrastructure and balance these against impacts expected to occur due to system operation. Exposure of an option to prominent environmental concerns, such as climate change, can be determined using the LCA technique, and where necessary, designs can be tailored to reduce impacts.

Figure 38: Assessment of water supply and treatment options [56].

Figure 38 illustrates how LCA results can be used to compare the lifetime environmental impacts of alternative water resource technology options, allowing designers to assess global warming impacts of various design options. The figure shows how LCA not only determines the total global warming impact of each option, but also breaks this down into design contributors. By using LCA in this way it is possible for decision makers to more effectively address drivers of environmental impact across the entire life cycle.

In seeking to use an alternative water resource in a new non-residential development, an underlying objective is to reduce reliance on centralised water supplies which are reaching capacity, in part, due to environmental constraints. In seeking to reduce centralised water demands, solutions need to consider broader environmental impacts so as not to exacerbate other environmental impacts, outside of water use. Greenhouse emissions are of particular concern, given their contribution to climate change. It is important that any alternative water supply option being considered in order to reduce potable water demand, does not exacerbate climate change, otherwise its effect on water supplies could in fact be counterproductive.
In addition, the economics of alternative water resource technologies could vary significantly over time as pressures increase to find cleaner energy supplies to run pumping processes in water supply systems. Stokes and Horvath [57] explain that 2-3% of energy consumed worldwide is used to pump and treat urban water and that energy requirements are expected to grow by 33% in the next 20 years.

“As readily available water sources are depleted, future supply options will likely have higher energy requirements.”[57]

Energy consumption at current prices in Australia will be unlikely to encourage efficiency in water supply/treatment system design, so an alternative decision consideration such as LCA needs to be incorporated. LCA, by looking more broadly, can reveal what elements of system design need to be optimised in order to reduce economic risks associated with energy cost exposures.

**Life Cycle Costing**

LCA is limited to environmental assessment. Life cycle costing, on the other hand, can be used to identify financial considerations for a technology or action over its lifetime:

“Life cycle costing is a process to determine the sum of all expenses associated with a product or project, including acquisition, installation, operation, maintenance, refurbishment, discarding, and disposal costs.” [58].

Life cycle costing is typically applied in a cash-flow framework, whereby projected future cash flows associated with a water treatment option, over its life, are discounted according to a prevailing interest rate to arrive upon a present cost of the system.

Discounting of future costs and benefits in this way is inconsistent with an environmentally sustainable view, making it important that a range of decision making tools such as LCA are used when considering alternative water supply options. This is not to say that financial considerations should be suppressed in favour of environmental concerns, but rather to recognise the tendency of life cycle costing within a discounted cash-flow framework will tend to undervalue future benefits.

The application of life cycle costing to alternative water resource technologies is primarily associated with balancing investments in treatment technologies against ongoing water supply savings. Life cycle costing provides a method for comparing costs associated with different supply options, allowing the analyst to determine a least cost option over the life of its operation. Typically such analysis would be undertaken against a reference scenario, usually supplying water to the development via a centralised reticulated network [56].

Life cycle costing data can be presented alongside water saving and LCA data when determining the viability of a supply system. This allows simultaneous consideration of issues such as greenhouse gas emissions with water savings, investment costs and net present value.
Urban water balance

Two of the three alternative water resources in this review rely on rainfall as the primary source of water: rainwater and stormwater. Designing alternative water resource technologies that use these resources requires modelling the urban water cycle in detail. Apparently simple questions such as storage capacity requirements in non-residential applications require detailed modelling to optimise [22].

There are a number of tools accessible to engineers that facilitate this modelling including, PURRS [36], MUSIC, UVQ and Aquacycle [22]. One of the more accessible tools, Aquacycle, is reviewed in more detail here.

“Aquacycle is a daily urban water balance model which has been developed to simulate the total urban water cycle as an integrated whole and provide a tool for investigating the use of locally generated stormwater and wastewater as a substitute for imported water alongside water use efficiency.”[59]

Aquacycle allows the technically trained user to determine key design parameters such as storage for a rainwater and stormwater system. It does so by modelling the urban water cycle described in Figure 39.

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**Figure 39: Urban water cycle as modelled by Aquacycle [59].**

In modelling the urban water cycle in detail it becomes possible to assess the impacts of strategies such as alternative water resources. Figure 39 shows a sample of the kind of output generated by Aquacycle. The detailed information provided quickly allows the impact of introducing an alternative water resource design into the water cycle. Even reuse and recycling impacts are addressed.
Moreover, Aquacycle and other similar tools provide an essential piece of information required for implementation of alternative water resources – their actual expected performance. Without understanding the expected performance of an alternative water system, especially rainwater and stormwater, it is difficult for non-residential users to assess the potential benefits of such systems.

The interaction of rainwater tanks as peak stormwater flow reduction tools can also be investigated using the PURRS (Probabilistic Urban Rainwater and wastewater Reuse Simulator) model. This will continuously simulate demand management (water saving devices) and the performance of rainwater harvesting and wastewater reuse to explore the reductions in rainwater tank demand, wastewater discharges and stormwater runoff that occur at an allotment-scale.

**Regulation Bodies and Requirements**

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Table 26: Summary of alternative water resource regulatory requirements, based on [27].

<table>
<thead>
<tr>
<th>ALTERNATIVE WATER SUPPLY SOURCE</th>
<th>KEY AGENCIES</th>
<th>ACTS &amp; REGULATIONS</th>
<th>POLICIES, CODES, STANDARDS AND GUIDELINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumbing Industry Commission</td>
<td></td>
<td>Plumbing Regulations 2004 – These regulations regulate the plumbing connections made between a rainwater tank to household supply systems and reticulation from the roof to the tank. They also regulate how a rainwater tank system can be connected to a reticulated drinking water supply system. <a href="http://www.austlii.edu.au/au/legis/vic/num_reg/par2004n174o2004408/">source</a>. Further information can be found at the Plumbing Code of Australia 2004 which can be purchased online at <a href="http://www.saiglobal.com/shop/script/details.asp?DocN=AS289952190845">source</a>.</td>
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<tr>
<td>Local Councils</td>
<td></td>
<td>Planning - Some local councils choose to apply planning measurements on the installation of rainwater tanks. These requirements are based on issues including the capacity of the tank, the nature of the structure to support the rainwater tank, whether there is a Heritage Overlay under the Planning Scheme and if the rainwater is for non domestic purposes. Please contact your local council for further information.</td>
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</tr>
<tr>
<td>Urban Water Authorities</td>
<td></td>
<td>Guidelines of Urban Water Authorities - Most Victorian urban water authorities provide more practical guidance targeting consumers interested in installing rainwater tanks. Please contact your local water authority for specific information.</td>
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<tr>
<td>Building Commissions</td>
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<tr>
<td>ALTERNATIVE WATER SUPPLY SOURCE</td>
<td>KEY AGENCIES</td>
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<td></td>
<td>EPA Victoria</td>
<td>Environment Protection Act 1970 - This act does not have specific provisions to regulate stormwater recycling. <a href="http://www.dms.dpc.vic.gov.au/Domino/Notes/LEMS/PublicLawToday.nsf/0/8a2ff0b1b0e3a58fca25703000055f6d$FILE/WE97-00856a146.pdf">http://www.dms.dpc.vic.gov.au/Domino/Notes/LEMS/PublicLawToday.nsf/0/8a2ff0b1b0e3a58fca25703000055f6d$FILE/WE97-00856a146.pdf</a></td>
<td>Melbourne 2030 – There are key initiatives as part of the Melbourne 2030 strategy that are relevant to stormwater management. (<a href="http://www.dse.vic.gov.au/melbourne2030online/downloads/2030_complete.pdf">Page 125</a>)</td>
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<td></td>
<td>State Government Victoria - Department of Infrastructure</td>
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<td></td>
<td>CSIRO</td>
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<td></td>
<td>Melbourne Water</td>
<td>Health Act 1958 – This act does not have specific provisions to regulate stormwater recycling. <a href="http://www.dms.dpc.vic.gov.au/Domino/Notes/LEMS/PublicLawToday.nsf/0/8a2ff0b1b0e3a58fca25703000055f6d$FILE/WE97-00856a146.pdf">http://www.dms.dpc.vic.gov.au/Domino/Notes/LEMS/PublicLawToday.nsf/0/8a2ff0b1b0e3a58fca25703000055f6d$FILE/WE97-00856a146.pdf</a></td>
<td>Water Sensitive Urban Design Engineering Procedures: Stormwater - Melbourne Water has developed and encouraged the use of Guidelines for the management of stormwater in urban areas. This manual is designed to give practical engineering solutions to the design of the elements of stormwater collection systems such as sediment basins, swales, and sand filters. The book can be purchased online at <a href="http://www.publish.csiro.au/nid/18/pid/4974.htm">http://www.publish.csiro.au/nid/18/pid/4974.htm</a></td>
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<td></td>
<td>Natural Resource Management Ministerial Council</td>
<td>Environment Protection and Heritage Council</td>
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<td></td>
<td>National Health and Medical Research Council</td>
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<td><strong>Greywater</strong></td>
<td>State Government Victoria</td>
<td>Environment Protection Act 1970- This act determines that discharges to the environment must be regulated in order to prevent damage to the environment. <a href="http://www.dms.dpc.vic.gov.au/Domino/Notes/LEMS/PublicLawToday.nsf/0/8a2ff0b1b0e3a58fca25703000055f6d$FILE/WE97-00856a146.pdf">http://www.dms.dpc.vic.gov.au/Domino/Notes/LEMS/PublicLawToday.nsf/0/8a2ff0b1b0e3a58fca25703000055f6d$FILE/WE97-00856a146.pdf</a></td>
<td>EPA Code of Practice, Onsite Wastewater Management, Publication 891.1 - This publication sets out requirements to achieve sustainable reuse, as opposed to disposal, for household wastewater. It sets out requirements for onsite wastewater systems and management to protect public health and the environment. <a href="http://epande2.epa.vic.gov.au/EPAPublications.nsf/2F1c2/625731746aa4a256ce90001cb65f788251d888479b7ca256940213c26/$FILE/891_1.pdf">http://epande2.epa.vic.gov.au/EPAPublications.nsf/2F1c2/625731746aa4a256ce90001cb65f788251d888479b7ca256940213c26/$FILE/891_1.pdf</a></td>
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<td></td>
<td>EPA Victoria</td>
<td></td>
<td>EPA Victoria (2005), Publication 1015: Guidelines for environmental Management: Dual pipe water recycling schemes – health and environmental risk management - These guidelines provide a preventative risk management framework for the management of dual pipe water recycling schemes involving garden watering and toilet flushing uses. It is required to have an approval from the EPA and endorsement from DHS for all dual pipe</td>
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<td></td>
<td>State government Victoria, Department of Human</td>
<td>Water Industry Act 1994 and Water Act</td>
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### ALTERNATIVE WATER SUPPLY SOURCE

<table>
<thead>
<tr>
<th>KEY AGENCIES</th>
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<th>POLICIES, CODES, STANDARDS AND GUIDELINES</th>
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</thead>
<tbody>
<tr>
<td>Standards Australia Plumbing Industry Commission</td>
<td>Building Act 1993 - The act recognised that there are potential health risks linked with the installation of alternative water supplies. These risks are discussed in the provisions of the AS/NZS 3500:2003 National Plumbing and Drainage Code and the Plumbing Regulations 1998, which include specific provisions for recycled water. <a href="http://www.austlii.edu.au/au/legis/vic/consol_reg/pr1998216/">http://www.austlii.edu.au/au/legis/vic/consol_reg/pr1998216/</a></td>
<td>EPA Victoria (2003) Publication 464.2: Guidelines for Environmental Management: Use of Reclaimed Water - This publication sets a framework for management of supply and reuse of reclaimed water from treatment facilities with a design or actual flow rate greater than 5000 L/day. Following these guidelines provides the basis for exemption of reuse schemes from EPA Victoria works approval and licensing requirements. <a href="http://epanote2.epa.vic.gov.au/EPA/Publications.NSF/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf">http://epanote2.epa.vic.gov.au/EPA/Publications.NSF/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf</a></td>
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<td>DHS (2004) Appropriate Use of Greywater - This publication sets out the appropriate greywater uses according to the level of treatment to minimise risks. <a href="http://www.health.vic.gov.au/environment/downloads/greywater_usage.pdf">http://www.health.vic.gov.au/environment/downloads/greywater_usage.pdf</a></td>
<td>AS/NZS 3500:2003 National Plumbing and Drainage Code – This code provides the standards of work for water services from the supply source to the point of discharge. In addition, it provides the requirements for the selection and installation of backflow prevention devices. To purchase the code please email <a href="mailto:sales@standards.com.au">sales@standards.com.au</a></td>
<td>EPA Victoria, The Do’s and Don’ts of Greywater Re-use - This publication provides safety tips for re-using greywater safely in domestic situations. <a href="http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/7dd91371d00bd654a256ce9001f4ac1/4fb5d827f4615eaaca25746d0004df7e5%20FILE1021.pdf">http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/7dd91371d00bd654a256ce9001f4ac1/4fb5d827f4615eaaca25746d0004df7e5%20FILE1021.pdf</a></td>
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<td>EPA Victoria (2002) Publication 760, Best Practice Environmental Management Series, Domestic Wastewater Management Series: Guidelines for Aerated On-site Wastewater Treatment Systems - This publication provides different design requirements, construction criteria and performance goals in which commercial aerated wastewater treats must achieve in order to receive the EPA approval. <a href="http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf">http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf</a></td>
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<td>EPA Victoria (2002) Publication 760, Best Practice Environmental Management Series, Domestic Wastewater Management Series: Guidelines for Aerated On-site Wastewater Treatment Systems - This publication provides different design requirements, construction criteria and performance goals in which commercial aerated wastewater treats must achieve in order to receive the EPA approval. <a href="http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf">http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf</a></td>
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<td>EPA Victoria (2002) Publication 760, Best Practice Environmental Management Series, Domestic Wastewater Management Series: Guidelines for Aerated On-site Wastewater Treatment Systems - This publication provides different design requirements, construction criteria and performance goals in which commercial aerated wastewater treats must achieve in order to receive the EPA approval. <a href="http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf">http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/2f1c2625731746aa4a256ce9001cb5d20aadc1ef3d03b6ca257d6701c13d0b5/F%20FILE1015.pdf</a></td>
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</tbody>
</table>

### Rebates
- In order to encourage water conservation, the Victorian Government offers rebates through its Water Smart Gardens and Homes Rebate Scheme. This scheme offers rebates from the water authority for installing water saving devices such as AAA shower roses, dual flush toilets, high pressure water cleaning devices, garden products, rainwater tanks and systems for re-using household wastewater (including greywater). <http://www.ourwater.vic.gov.au/saving/home/rebates>
**Recycled Water (Treated Wastewater)**

**Key Agencies**
- EPA Victoria
- Waters of Victoria
- State government Victoria, Department of Human Services
- Standards Australia
- Plumbing Industry Commission

**Acts & Regulations**

- Environment Protection Act 1970 – For many years, the use of wastewater (recycled water) has been actively regulated under the Environment Protection Act 1970 (EP Act). Under the EP Act, the regulatory framework relies on the planning of actual flow rate.
  
  [http://www.dms.dpc.vic.gov.au/Domino/We b_Notes/LDMs/PublawToday.nsf/f8ba2ff6 e7b1c205d0c257030000954d/$FILE/70- 0056a146.pdf](http://www.dms.dpc.vic.gov.au/Domino/We b_Notes/LDMs/PublawToday.nsf/f8ba2ff6 e7b1c205d0c257030000954d/$FILE/70- 0056a146.pdf)

- Victorian Planning Provisions, Clause 15.01 and Clause 18.08-2 – These clauses requires that all decisions must be consistent with State Environment Protection Policy Waters of Victoria and the responsible authorities to keep consistent with the Septic Tank Code of Practice.
  

**Policies, Codes, Standards and Guidelines**

- 2003 State Environment Protection Policy - Waters of Victoria – This policy outlines the requirements for managing domestic wastewater. Clause 17 claims that Councils have various responsibilities which impact on surface waters, including the planning and approval of domestic wastewater management. Clause 32 states that on-site domestic wastewater is required to be managed in order to prevent the transport of nutrients, pathogens and other pollutants to surface waters and to avoid any impacts on groundwater beneficial uses.
  

- 2003 Guidelines for Environmental Management: Use of Reclaimed Water. Publication No. 464.2 – This publication sets framework, water quality criteria and performance targets for the supported uses of treated wastewater.
  
  [http://epanote2.epa.vic.gov.au/EPA/publications.nsf/2f1c2625731746aa4a256ce90010cbb5/64c2a159697f5e184a2 569a00025d63/$FILE/464.2.pdf](http://epanote2.epa.vic.gov.au/EPA/publications.nsf/2f1c2625731746aa4a256ce90010cbb5/64c2a159697f5e184a2 569a00025d63/$FILE/464.2.pdf)

- EPA Victoria (2005), Publication 1015; Guidelines for environmental Management: Dual pipe water recycling schemes, health and environmental risk management - This publication provides a preventative risk management framework for managing dual pipe water recycling schemes for residential reuse. All these schemes require the approval of the EPA and endorsement from DHS.
  

- EPA Victoria Certificate of Approval System - Domestic Wastewater Management Series. This certificate is a brief statement which summarizes the approval processes for households’ onsite wastewater systems by the EPA and local government.
  

- 2002 Guidelines for Aerated On-site Wastewater Treatment Systems – Domestic Wastewater Management Series, Publication 760 – This publication sets out construction requirements, design criteria and performance objectives in which these systems need to adhere to in order to receive approval under section 53 M (9) of the EP Act 1970. The guidelines are aimed to provide manufacturers of these systems with guidance and certainty.
  

- EPA Victoria Land Capability Assessment for Onsite Domestic Wastewater Management Publication Bulletin 746.1 – This bulletin provides tools to various stakeholders and councils about for assessing the suitability of a site for septic tank installation. It also offers guidance as to the management and operation of septic tank systems.
  

- 2003 Septic Tanks Code of Practice Publication 891.1 - This publication is aimed to ensure that human health and the environment now in and in the future are protected when on-site wastewater treatment systems are used in areas not served by a centralised sewerage system.
  